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BALANCING RESERVOIRS TO SUPPLEMENT PUMP CAPACITY DURING PEAK DEMANDS[1]

By Edmund K. Barnum[2]

In cities where the topography is more or less level and natural, elevated storage sites cannot be obtained, the question of meeting the maximum hourly demand with pumps or gravity water becomes a problem of designing the works to meet the peak conditions or supplement the above with stored water, from elevated tanks or surface reservoirs with booster pumps. In the former case a large investment in major equipment results, with corresponding fixed charges often passing the economic limit, while in the latter case, we are confronted with the problem of balancing annual operating expense, plus fixed charges on our pumping equipment, against that of meeting the peak demand or a percentage thereof, with stored water from balancing reservoirs.

As the economics of the problem require a careful study of load factor conditions, on each particular system, before storage capacity should be decided upon, this phase of the problem will be touched upon but briefly, as it is believed the economics to be somewhat outside of the scope of this report.

A hypothetical water works plant will be considered, and a method outlined of determining the relationship between maximum hourly demand and pump capacity versus storage requirements.

[1] Presented before the California Section Meeting, October 16, 1925.

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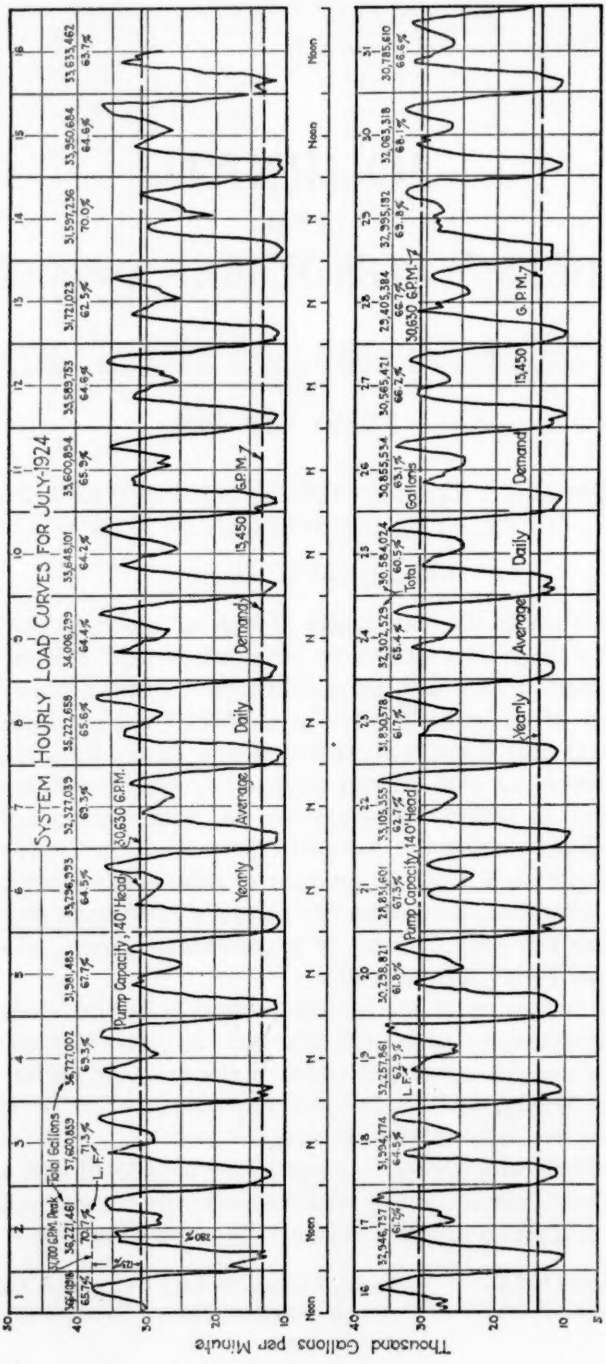
System Hourly Load Curves for July-1924
Thousand Gallons per Minute
Pump Capacity, 140' Head
30,630 G.P.M.
Yearly Average Daily Demand
13,450 G.P.M.
Total Gallons
L. F.
37,700 G.P.M. Peak
Noon
N

FIG. 1

A city of 80,000 inhabitants will be considered operating on a flat rate basis, the average daily demand being 19.5 million gallons total consumption of water measured at the pumps. We shall assume that the supply is being pumped from the underground waters, and that the plants are distributed throughout the city and pump directly into the mains. Any additional pumping plants must be so located that interference between wells or overlapping of cone of depression will not be obtained, and that there is a limit to the number of pumps which can safely be installed in the area considered.

Figure 1 is submitted herewith and shows the hourly load curve for the maximum month of the year studied, and represents the demand expressed in gallons per minute. The total consumption for the month is 1016 million gallons or 22,750 gallons per minute; this represents an average monthly load factor of 60.4 per cent. From a study of the performance curve of each pump, the capacity in this case was taken at a total head of 140 feet and then summarized, the result being the available supply at such a head, (namely 140 feet) that normal service could be rendered. This is seen to be 30,630 gallons per minute. At all points wherein the demand curve is seen to be above the available supply line, then auxiliary capacity is required either in the form of additional pumps or storage released. It is to be noted that there are only three or four days of the entire month that normal service could be rendered with the present pump capacity.

In order further to study the condition, the three maximum days have been selected from figure 1, and reproduced on figure 2, together with a mass curve showing accumulative pumpage for this period. The mass curve is of the usual form, the demand line being accumulative pumpage, while the supply line represents available supply at 140 feet total head. Any line parallel to the supply line, and drawn tangent to the demand line, has a maximum ordinate whose value represents deficiency in supply. This is further shown on the hourly load curve, as all areas above the available supply line, can be integrated and storage requirements determined. Summarizing the above, then, it is seen that:

(1) The average daily demand for the year = 19.5 m.g.d.
(2) Pump capacity at 140 feet head = 30,630 g.p.m.
(3) Maximum hourly demand (three day average) = 36,764 g.p.m.

(4) For approximately 10 hours for each of the three days selected, the demand was equal to or greater than the available supply, resulting in service being rendered at a reduced pressure head
(5) Pump capacity in per cent of average daily demand = 227
(6) Peak demand (three day average) in per cent of average daily demand = 273
(7) Peak demand in per cent of pump capacity = 120

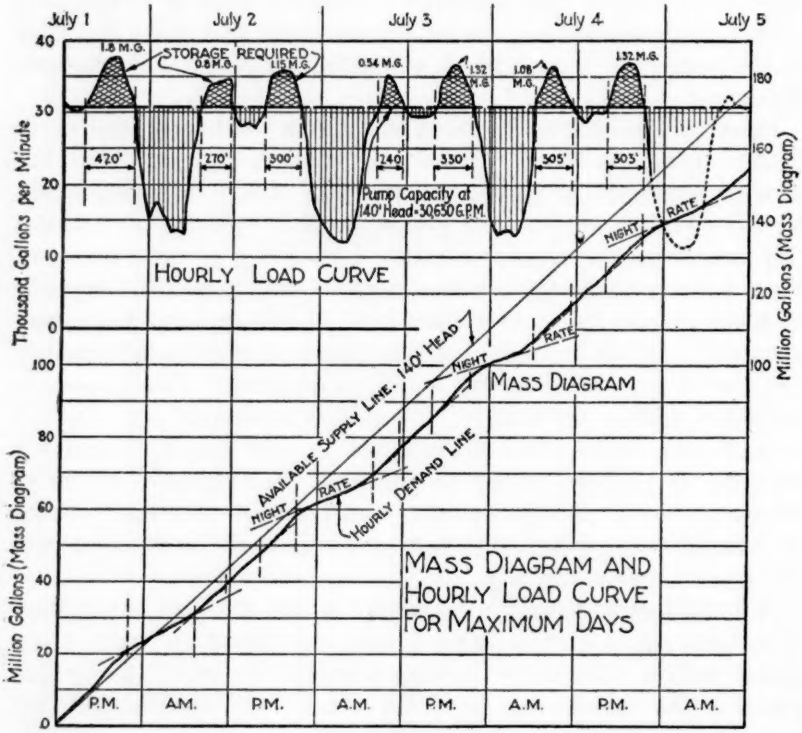

FIG. 2

By reference to the mass diagram it is seen that the average night rate of flow is about 12,500 g.p.m., while the average rate during maximum demand period is about 33,000 g.p.m., or approximately 264 per cent of the night flow.

Figure 3 is now plotted as an average curve for the three maximum days and reflects the average system operating conditions from which final conclusions may be drawn, as to deficiency in supply during peak demand period, and pump capacity. From 4:00 p.m. until

9:30 p.m. it is obvious that the pump capacity should be either increased or auxiliary supply furnished in the amount of 1.35 m.g. If reservoirs are provided the 1.35 m.g. mentioned above, and about 600,000 gallons during the morning load, or from 7:00 a.m. to 11:30 a.m. or about 20 per cent more capacity is required to equalize the flow during peak conditions.

The operating condition of the system during this three day maximum period are shown in figure 4. It is seen at once that, to supply the peak demand of 36.764 g.p.m., storage or auxiliary supply is necessary; with a pump capacity of 30,630 g.p.m., representing approximately 227 per cent of the yearly average daily demand, there remains a deficiency in the amount of about 17 per cent of

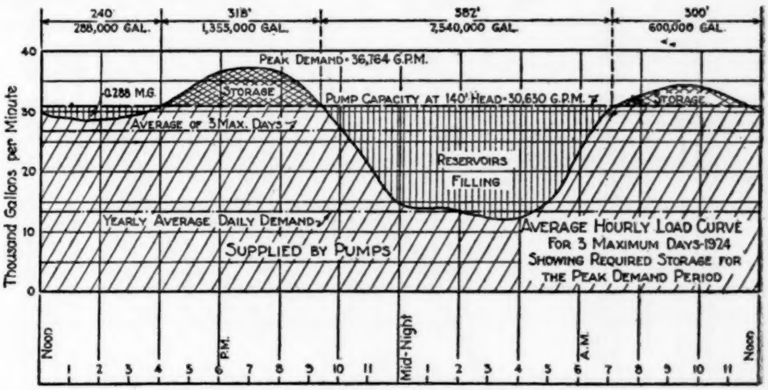

FIG. 3

the peak demand to be provided. Figure 4 is further useful in the determination of the economic solution of this problem, as the cost of storage expressed in terms of per cent of peak capacity is readily balanced against the cost of equivalent pump capacity in terms of per cent of yearly average daily demand.

It is assumed herein that, if storage is to be provided, it will be utilized throughout the year, and the pumping plant so operated that maximum use of stored water will be obtained. By this scheme of operation certain plants may be shut down as the average daily demand decreases, allowing the remaining plants to operate at a higher load factor and efficiency, which is very desirable in a system of this kind.

The economics of storage versus additional pump capacity should

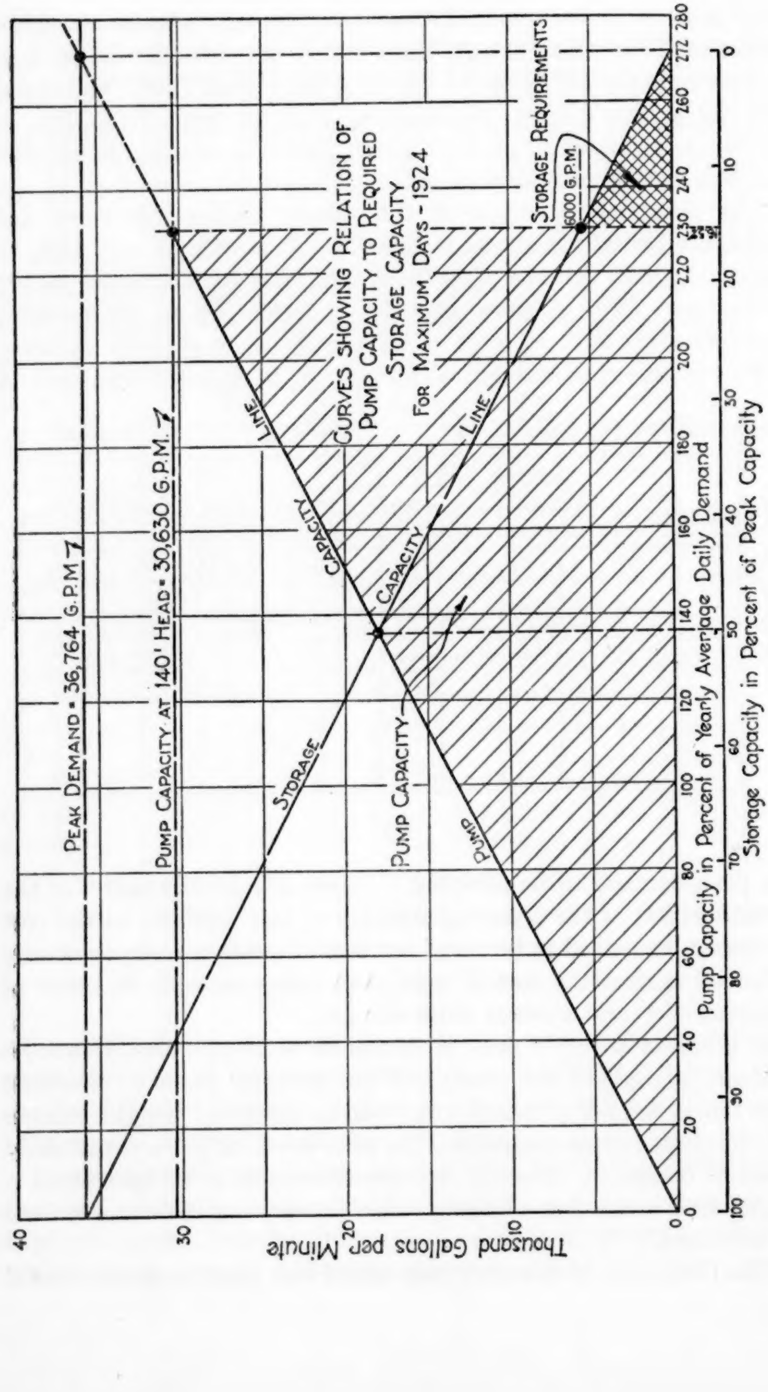
Curves showing Relation of Pump Capacity to Required Storage Capacity For Maximum Days - 1924
Peak Demand = 36,764 G.P.M.
Pump Capacity at 140' Head = 30,630 G.P.M.
Storage Capacity Line
Pump Capacity Line
Storage Capacity
Pump Capacity
Storage Requirements 6000 G.P.M.
Thousand Gallons per Minute
0
10
20
30
40
Pump Capacity in Percent of Yearly Average Daily Demand
0
20
40
60
80
100
120
140
160
180
200
220
230
240
260
272
280
Storage Capacity in Percent of Peak Capacity
100
90
80
70
60
50
40
30
20
10
0

FIG. 4

now be studied, and the annual cost of operation plus fixed charges of both schemes balanced. There will be found a point or a balanced condition wherein the total annual cost of operation of pumping plants, expressed as a percentage of average daily demand, will be equal to the corresponding annual cost of operation of storage reservoirs, expressed as a percentage of the peak demand. Having found this balanced cost condition and it is deemed desirable to store water in elevated reservoirs, the pressure conditions in certain selected zones should be scrutinized and the average pressure per hour plotted, as shown on figure 5, from which the proper elevation of stored water may be obtained.

Recording pressure charts are almost indispensable in the pressure survey. These should be carefully adjusted and proper calibration maintained. I find it convenient, in a study of this kind,

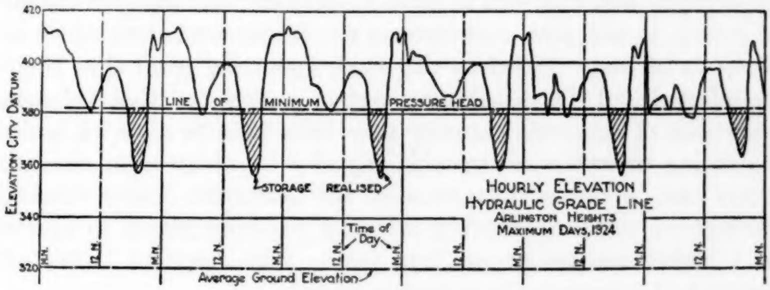

FIG. 5

to determine the elevation of these gages referred to City Datum from which the elevation of hydraulic grade at any point on the system is noted, and comparison is made.

Referring to figure 5 again, your attention is directed to the hourly pressure, and a suggested method of determining the dimensions, and elevation of elevated reservoirs for this particular case. If the tank is to operate automatically, and fill from the mains during the off peak hours, and discharge during periods of large draft, then the bottom of the reservoirs should be placed at such an elevation that a reasonable pressure head will be maintained until the heavy draft has stopped, and the pressure rises in the mains to the point of filling the tank. Sufficient friction head should be allowed between the pressure head in the mains and the capacity line in the reservoir so that the tank will fill rapidly during the off peak hours. An estimate of the required friction head, can be obtained by again

turning to the mass diagram. It will be noted that the lines B-B are drawn parallel and tangent to that portion of the mass diagram, which indicates the night flow. The rate of flow for this period is seen to be about 12,500 g.p.m. for the two twenty-four-hour periods studied. If reservoirs are provided to the amount of $2\frac{1}{4}$ m.g., then they also must be filled during this period which will increase the night rate of flow by the time decided upon to fill the reservoirs. An estimate can then be made of the allowable time to fill the reservoirs from which the proper friction head can be determined.

SUMMARY AND CONCLUSIONS

Before an extensive construction program is undertaken for a City, in which the problem is one of pumping from the underground waters, and the consumption of water is relatively high, the water department would do well to make a comprehensive study of the rate of growth in the past, and forecast the future conditions which are likely to be met. Based on this study, pumping plant sites should be selected and the distributing system so designed that balancing reservoirs of economic capacity may from time to time be added. Balancing reservoirs of suitable capacity based upon an economic study can be provided to equalize the maximum hourly demands throughout the year, thereby allowing pumping plants to operate at a higher average annual load factor, with resultant better efficiency and corresponding saving in power.

Reservoirs in the form of elevated tanks, or stand pipes, are easily constructed and maintained. Their economy in annual costs offer a solution in many cases to meeting the peak conditions. Their adaptability to smoothing major fluctuations in pressure is recognized. An altitude valve or other automatic device should preferably be installed in the discharge line of the tank, thereby, allowing complete automatic behavior.

Frequently a slight elevation can be found in cities, even though the general topography is assumed to be flat. In this case there is sometimes experienced some difficulty in serving consumers, particularly on the peak. This case may be treated separately, and the district isolated by means of check valves in the trunk supply lines, and storage provided sufficient to care for the demand, based on local studies, rather than the system condition. It is obvious that the check valves should be so located and the tank be placed at such an elevation that flow during off peak hours will store the water,

and it will be ready for use when the next cycle of lowering of system pressure occurs.

Stored water is also an asset from the point of view of fire protection. It should be given some weight in this consideration, more so perhaps, if the entire supply is being pumped, than if it is from a gravity source.

Regarding the aesthetics of elevated tanks and towers, much can be said. The conventional design of elevated tanks and steel towers may be so modified as to harmonize with the surrounding buildings and structures.

DESIGN AND CONSTRUCTION OF CONCRETE-LINED DISTRIBUTING RESERVOIRS[1]

By I. E. Flaa[2]

FUNCTION

Distributing reservoirs are used for receiving water from long conduits, leading from the source of supply into the cities and there regulating the flow into the distributing system. This regulation of flow is necessary due to variation of consumption during a twenty-four-hour period, the maximum consumption for a short period being greater than the carrying capacity of the conduit, and also to give a continuous supply to the district during the period of shut down on the conduit due to accident or other causes.

Distributing reservoirs are also used for regulating the flow and pressure in pumping systems.

The capacity and location of distributing reservoirs depend upon the requirements of the district to be served. The type depends upon the physical character of the available sites.

Among the important types are the

1. Excavation and rolled embankment in earth with the necessary impervious lining
2. Concrete, steel and wood tanks
3. Standpipes

In a distributing system it is desirable to maintain a pressure between 40 and 50 pounds at the tap. Thus it will be seen that in any city, having a wide range of elevation, in order to maintain the pressure of 40 to 50 pounds, the area must be divided in zones between every 100-foot rise in elevation, thus requiring some regulating device for each zone or pressure district. A flat city will require only one regulating reservoir or possibly two.

In San Francisco, with elevations varying from sea level to nearly 1000 feet above sea level, seven distributing reservoirs and fourteen

[1] Presented before the California Section meeting, October 16, 1925.

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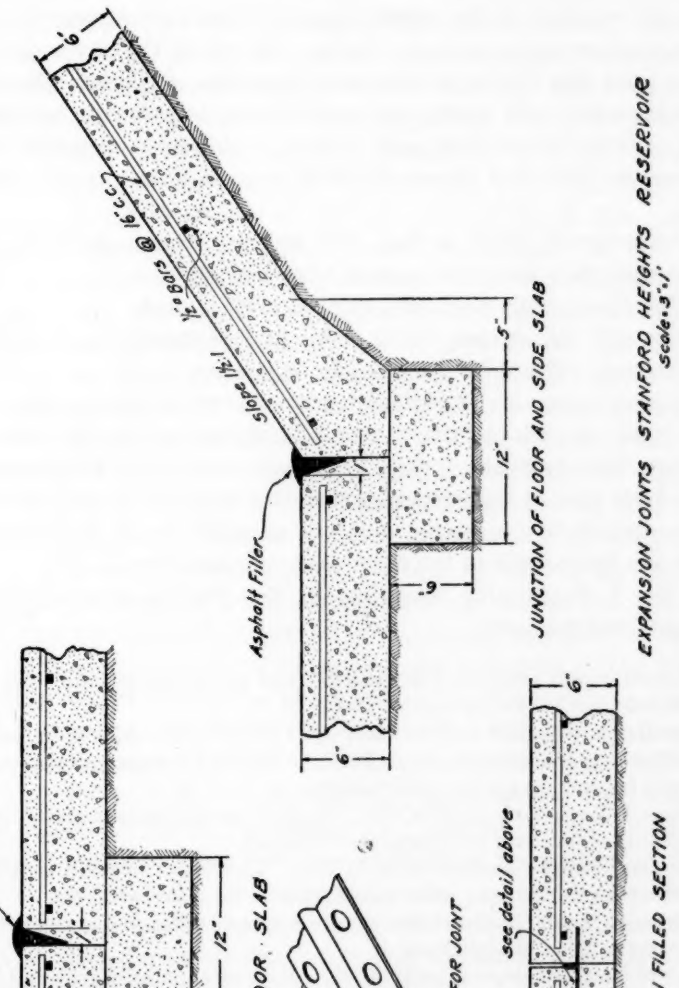

6"
½"ø Bars @ 16" c.c.
slope 1½:1
5"
12"
6"
6"
Asphalt Filler
JUNCTION OF FLOOR AND SIDE SLAB
EXPANSION JOINTS STANFORD HEIGHTS RESERVOIR
Scale 3"=1'
Asphalt Filler
½" Bars 16" c.c.
6"
6"
12"
FLOOR SLAB
1/16 x 8" Sheet Lead
2" Dia. Holes - 6" c.c.
DETAIL OF LEAD FOR JOINT
see detail above
6"
½" Bars 16" c.c.
SIDE SLAB ON FILLED SECTION

FIG. 1

tanks are required at the present time to regulate properly the flow in the nineteen major pressure districts into which the city is divided.

The East Bay Cities of Oakland, Alameda, Berkeley, Hayward and Richmond, with towns and communities in between, served by the East Bay Water Company, with a variation in elevation from sea level to 1400 feet above sea level, require 25 reservoirs and 17 tanks.

In Sacramento, which is flat, only one reservoir is used and that is in conjunction with the present filtration plant.

In San Jose, another flat city, one reservoir is used.

Tanks and standpipes, being more or less standardized in their construction, will not be discussed in this paper.

The excavation and rolled embankment reservoirs require a detailed study in each and every case. First, the location is limited to a predetermined elevation, there being only a relatively small number of available sites at the particular elevation required in the proximity of the district to be served, a study must be made to determine which one lends itself to the most economic construction.

Of the 7 distributing reservoirs in San Francisco 6 were built between 1860 and 1897:

Lombard Street reservoir built in 1860, was excavated in solid rock with low embankment lined with brick.

Lake Honda reservoir built in 1861, is a natural basin, sides trimmed and these trimmings placed in bottom. Portions of both the sides and bottom are lined with brick and a portion with concrete.

College Hill reservoir built in 1870. Excavation and tamped embankment with a lining of clay over which was placed riprap.

Francisco Street reservoir built in 1860. Excavated in solid rock with tamped earth embankment, lower side lined with brick and concrete.

University Mound built in 1885. Excavation and rolled embankment lined with concrete, felt and asphaltum.

Potrero Heights reservoir built in 1897. Excavated in solid rock and lined with brick.

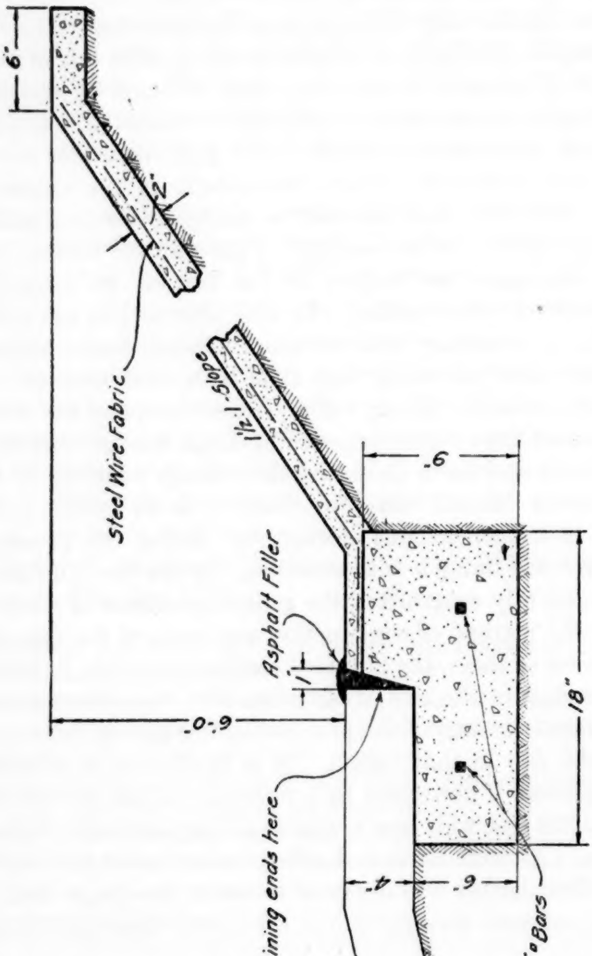
Only one of these reservoirs was covered and that covering was burned down in 1906 and was not replaced until 1919.

In the earlier years of the Company's development it was found unnecessary to cover distributing reservoirs to eliminate contamination from algae or other sources, but in the past twenty years the sea gulls have increased in great numbers and seem to have an affinity for fresh water, persisting on congregating in and about the open reservoirs causing more or less trouble.

The reason for the ever increasing numbers is that they are now protected by law. In the olden days, as now, the gulls hatched and reared their young on the Farallon Islands about 25 miles out in the ocean west of San Francisco. These eggs were collected by certain individuals and sold in the markets as food, and were used principally in the baking and confectionery trades. The gulls were also shot and used as various forms of chicken particularly in the chicken tamale. If this condition were allowed to continue the sea gulls would have become extinct in this section. Thus with the protection that this lowly scavenger now enjoys he has become an item of importance in reservoir construction. In 1919 due to this sea gull trouble it was found necessary to cover our Francisco Street reservoir—and all reservoirs built since that time have been covered.

In the past three years the Spring Valley Water Company has constructed two concrete-lined reservoirs, each having a storage capacity of 5 million gallons, and have increased the storage capacity of a third—the University Mound reservoir—from 41 to 59 million gallons, a gain of 18 million gallons storage, by raising the present embankment 6 feet and lining it with concrete. In the two 5 million gallon reservoirs recently constructed the general problems of design were similar but the method of construction and some of the details were different. One of these, the Stanford Heights reservoir, located in the western portion of the city at elevation 600, was constructed to meet the increased demand of the new residential district between elevations 400 and 500 in that region. It is located on a hillside having a slope of about 7 horizontal to 1 vertical. A full city block 663 feet long and 228 feet wide was available at the particular elevation and location. An excavated and rolled embankment reservoir for 10 million gallon storage was designed to cover the entire block, with a reinforced concrete division wall in the center dividing it into two equal parts.

For our present needs only one-half capacity or 5 million gallon storage was required so the westerly half was constructed in the spring of 1923. This portion is 300 feet by 155 feet on top, 215 by 88 feet on the bottom, and is 22 feet deep with inside side slopes of 1½ to 1 and outside embankment slope of 2 to 1, and crest of embankment 10 feet wide. It is lined with a 6-inch slab of reinforced concrete placed in 30-foot squares on the bottom and 20-foot by 40-foot sections on the sides. This lining has a total of 0.5 per cent temperature reinforcing, or 0.25 per cent in each direction, consisting of ½-inch



EXPANSION JOINT—JUNCTION OF OLD AND NEW WORK.
UNIVERSITY MOUND RESERVOIR
Scale 3" = 1'

FIG. 2

square bars spaced 16 inches both ways; each section is separated from the adjoining section by expansion joints which will be referred to in detail later. A tar and gravel roof is supported by 8-inch by 8-inch precast reinforced columns 24 feet long spaced 20 feet apart; these columns are reinforced with four ½-inch bars and were set in precast concrete footings grouted to the floor and side slabs. The roof beams are two 3-inch by 12-inch Oregon Pine, 20 feet long, rafters are 2 inches by 8 inches by 20 feet long, spaced 30 inches, on which is placed a 1-inch by 10-inch pine flooring covered with a paper tar and gravel covering. The excavation and rolled embankment was made as if the entire 10 million gallon reservoir was to be finished, leaving the easterly end open. This end was closed by a reinforced concrete division wall designed and constructed to withstand the full head of water from either side, the other side being empty. This wall is 22 feet high 10 inches thick on top and 15 inches thick on the bottom and is supported with 14-inch thick counterforts on both sides spaced about 9 feet apart. The wall and counterforts rest upon a slab of concrete 20 feet 3 inches wide and 22 inches thick. The outlet gate and screens are contained in a square concrete tower set in the division wall and made a part thereof. It is divided into three compartments, so arranged that either half of the ultimate 10 million gallon reservoir can be operated independently of the other half. Two 24-inch cast iron pipes lead from the tower through a concrete culvert under the embankment to the mains in the street and one 12-inch cast iron drain pipe connects with the sewer.

Bids were called for, the contractor to furnish labor and material, excepting the pipe, sluice gate, gate valves for the outlet works. These were to be furnished and installed by the owner. The owner also was to furnish and place the plastic material in the expansion joints. Three bids were received ranging from $62,400 to $70,200, and the lowest bidder got the job for $62,405.50.

A steam shovel was used for excavating and the material transported to the embankment by dump wagons where it was spread in 4-inch layers, wet down and rolled with 10-ton roller. This excavation was carried to within 2 or 4 inches of the final grade, then trimmed to grade and made ready for the concrete lining; during the excavation, springs were encountered which were drained by a 6-inch cast iron pipe along the toe of cut on the uphill side, thence under the division wall through the embankment on the downhill side. No further trouble was encountered from that source. After the

floor and side slabs were poured the roof columns were erected by a derrick using a Ford truck for power which ran on the completed floor.

The contractor finished his work in three months. The owner then cleaned the expansion joints and placed the plastic material, which in this case was a patent compound—a combination of tar and asbestos filler.

This material was delivered on the job in barrels, which when opened was found to be of different consistency. Some was so thin that it could not be poured in the side joints but was used on the floor. The rest was thick enough to be placed with a trowel. After this experience an inspector was placed at the plant where this material was made and from then on the material received was of proper consistency.

Two types of expansion joints were used. In the embankment lead joints were used and on the cut portion tar joints were used.

NILES RESERVOIR

Niles reservoir, as the name implies, is near the town of Niles, Alameda County, about 30 miles southeast of San Francisco, and serves as a regulator at the head of the pipe line leading from that point into the city. It receives its water from the recently reconstructed concrete aqueduct in Niles Canyon. This aqueduct consists of four covered concrete flumes and five concrete-lined tunnels, and has a capacity of 70 million gallons daily.

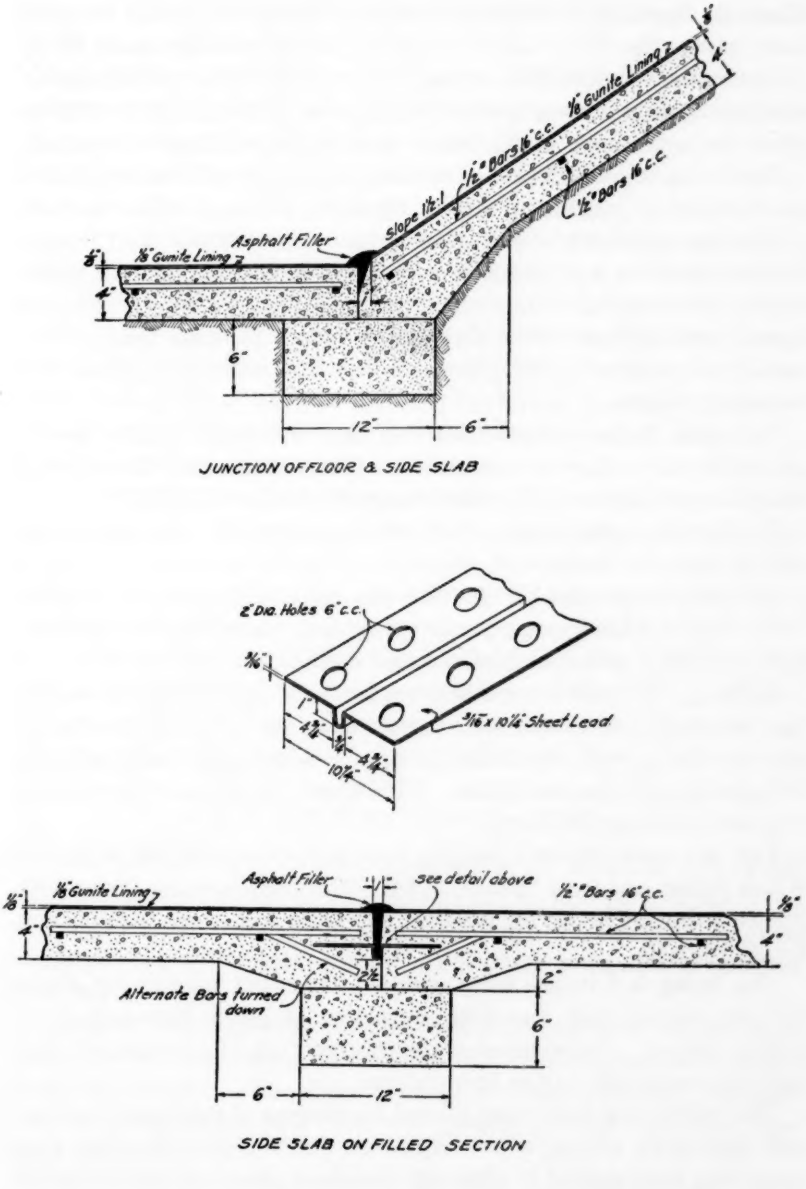
The capacity, type and dimensions of this reservoir are practically the same as Stanford Heights reservoir.

The only important difference is in the concrete lining, the inlet and outlet structures and the overflow spillway, having a capacity of 70 million gallons daily. This reservoir has no division wall.

The reservoir is located about 75 feet north from one of the aqueduct tunnels, which in this particular place was some 5 feet under ground. A shaft was sunk at the point nearest the reservoir and a concrete box built from which a 5-foot by 5-foot inlet tunnel was constructed to the reservoir.

The outlet structure consists of a 4-foot by 4-foot horseshoe culvert under the embankment connecting with the 44-inch pipe line, the outlet flow being controlled by a 4-foot by 4-foot sluice gate at reservoir end of this culvert.

The spillway over the crest of the reservoir is 25 feet long with



EXPANSION JOINTS NILES RESERVOIR
Scale 3" = 1'

FIG. 3

allowable depth of 3 feet from which an 8-foot by 2-foot concrete chute carries the water 125 feet down a steep hillside to a small creek.

The excavation and fill contract was let in the fall of 1923 and after completion was allowed to stand through the winter of 1923–1924 to allow for settlement of fill before the concrete lining was placed.

The lining is a 4-inch slab of reinforced concrete without expansion joints except at junction of side and bottoms and on the four corners.

The top soil for a depth of 4 inches was stripped and wasted. Fordson tractors and scrapers were used in excavating and transporting the material to the embankment where it was spread in 4-inch layers, wetted, then rolled thoroughly with a Fordson tractor converted into a roller by filling in the wheels with concrete to give it the necessary weight.

The crest of the embankment was carried 6 inches above the required height to allow for settlement. This did not occur as expected and the crest had to be trimmed to grade at a later date.

During the construction of the embankment the concrete outlet culvert was also built.

The excavation and fill contract was completed in three months.

There was 13,000 cubic yards excavation placed in the embankment and 2400 cubic yards of stripped material wasted.

In May, 1924, bids were called for, for trimming, lining and roofing the reservoir. Alternate bids were asked for a 6-inch reinforced concrete lining with expansion joint, or a 4-inch reinforced concrete lining without expansion joints. This 4-inch lining was to be covered with an $\frac{1}{8}$-inch gunite lining.

Ten bids were received ranging from \$28,000 to \$52,000 using the 6-inch lining, and from \$28,000 to \$47,500 using the 4-inch lining with gunite finish. The lowest responsible bidder was given the contract for \$30,419.80.

The lining is 4 inches thick with 0.75 per cent reinforcing, about 0.4 per cent in each direction, consisting of $\frac{1}{2}$-inch bars spaced 16 inches centers. No expansion joints excepting at junction of floor and side walls and on the four corners.

The reinforcing bars were placed continuous throughout the floor and side slabs except where expansion joints occurred. The concrete was then poured in alternate panels of about 20 by 30 feet on the bottom and 13 by 33 feet on the sides.

The mixture was $1:2\frac{1}{2}:3\frac{1}{2}$, with a minimum of 8 per cent hydrated lime. A rather wet, but not sloppy, mixture was used in the floor

slabs; on the side slopes the mixture was made dry enough so that it would stand without forms.

Just before the initial set had taken place small surface cracks appeared. No concern was felt over their appearance, on account of the gunite coating which was to be added. However, they were rubbed out with a wood float and only in a few instances did they reappear. These cracks were probably due to the top of the concrete drying out before the initial set. Thereafter water was applied to the concrete immediately after the initial set and was kept wet ten days after pouring.

After the roof columns were set and the roof completed the cement gun or gunite finish of $\frac{1}{8}$-inch minimum thickness was placed. When finished the coating was nearer $\frac{1}{4}$ inch thick than $\frac{1}{8}$ inch. The gunite mix was one part cement to three parts Marysville sand, screened to eliminate any pea gravel.

A relatively dry consistency was used. The water being added in the cement gun. Air pressure of 50 pounds was supplied at the gun by an air compressor driven by a gasoline engine.

The crew consisted of six men, four men actually operating the plant and two men sweeping up and cleaning away the rebound which amounted to from 10 to 15 per cent of the sand used. This crew was able to cover about 1200 square yards a day. The work was finished in four months' time and the reservoir has been in operation about one year without any trouble.

RAISING UNIVERSITY MOUND RESERVOIR

This reservoir, built in 1885, is located in the southern part of the city at elevation of 165 feet, regulates the supply to practically all the commercial and manufacturing sections of the city. In fact, about one-half of the total supply into the city is regulated from this reservoir.

The crest of the embankment was about 30 feet wide, which would allow a 6-foot fill to be placed on top without making the old embankment any thicker. The total perimeter of the reservoir was 2400 feet of which about 600 feet was excavation and 1800 feet was embankment.

This embankment was raised 6 feet with material borrowed from the adjoining property and transported to the embankment by wagons, when it was spread and rolled in the usual manner, then trimmed and made ready for the concrete lining.

This lining is 2 inches thick with about 0.7 per cent reinforcing consisting of two layers of No. 8 gauge steel wire fabric.

After the embankment was trimmed to the proper grade and the reinforcing in position concrete was placed with a cement gun in about the same manner as on the Niles reservoir.

TABLE 1

Table of costs

	STANFORD HEIGHTS RESERVOIR	NILES RESERVOIR	RAISING UNIVERSITY MOUND RESERVOIR
Capacity, million gallons	5	5	18.4
Total cost, dollars	$68,725.86	$58,850.88	$27,008.25
Cost per million gallons storage	$13,745.00	$11,770.00	$1,468.00
Per cent of total cost			
Stripping	2.7	2.9	
Excavation and fill	22.4	18.8	24.7
Trimming	2.7	4.9	2.7
Lining	31.9	34.0	34.2
Roof	18.7	14.4	
Structures	8.6	12.9	22.9
Division wall	9.9		
Gunite coating		4.9	
Retaining wall			9.6
Engineering	3.1	7.2	5.9
	100.0	100.0	100.0
Other data			
Time to complete	3 months	7 months	4 months
Kind of lining	6″ expansion joints	4″-1/4″ gunite	2″ gunite
Cost of lining per cubic yard	$21.89	$23.67	$47.19
Cost of lining per square foot	42 cents	32 cents	29 cents
Cost of gunite coating, square feet		4½ cents	
Cost of roof per square foot	27 cents	14 cents	

The full 2 inches was shot at the same time. At the end of each day's run a feather edge construction joint was left on which to start the next day.

An expansion joint was constructed at the junction of the old and new lining.

LAYING CAST IRON MAINS: ORGANIZATION AND METHODS[1]

By Homer V. Knouse[2]

The installation of water and gas mains in the Metropolitan Utilities District of Omaha, Nebraska, is done almost entirely by District forces, the only exception during the past few years being certain lines of 36-inch and 48-inch diameter which were handled by contract. Following the purchase of the water plant by the City of Omaha in 1912, it was found that there was a considerable amount of extension to the distribution system of the water plant necessary, and inasmuch as men trained in laying water pipe were a part of the organization, the installation of water mains by District forces was a natural course of procedure. With the growth of the City, and to meet the increased demands for extension following the war, more gangs were organized by selecting foremen from among the men in the older gangs, and by training caulkers and pipe men under the older foremen. With the acquisition of the gas plant in 1920, still further demands were made upon the Construction Division and the needs were met by the same method of expansion.

Foremen, caulkers, pipemen and a few laborers are considered regular employees of the District, and during the winter or at times of decreased activity, the total number of men employed is decreased by laying off common labor which have been employed on the various gangs. At such times regular employees are employed on inspection, main flushing, repairs and incidental work.

Installation of water and gas mains is a specialized class of work, requiring foremen and skilled labor not generally available in the labor market, and where it is possible to hold together the nucleus of a trained organization from year to year, it seems evident that cheaper and better work can be done than under the contract system where organizations are built up and torn down, not only from year

[1] Presented before the Iowa Section meeting, December 3, 1925.

[2] Construction Engineer, Metropolitan Utilities District, Omaha, Nebraska.

to year but from month to month. Since an organization can be built at the beginning of a season with knowledge of the total amount of work to be done, with the assurance that it can be employed nearly full time, a more efficient personnel will be retained. Under this plan there is always available a considerable number of men for emergency work in the distribution system or at the various plants; the work is more closely under the control of the District and changes in plans are most easily made. Since each foreman is interested in the operation of the system, as well as in its construction, he is in effect an inspector for the District, is on the alert to note changes in the plans which would increase the effectiveness of the work he is installing, and is able to meet difficulties or obstructions which he may encounter of which the Engineering Department had no record or knowledge at the time the plans were made.

A factor greatly affecting the progress and cost of work is a careful planning of the order in which the various jobs shall be done. Moves of machines or gangs should be as short as possible; trench should be opened ready for the gang to begin work; pipe and specials should be on the ground, and the gang foreman should have complete maps in his hands when ready to begin work. Since ditching machines, backfillers and all other special machinery are operated as units separate from the pipe laying gang, and usually serve several gangs, it is necessary that they be routed separately. In general, the plan of work is made with respect to the ability of the ditchers to open trench, and as many gangs as are necessary to keep up with the machine are routed behind the ditcher. Where backfillers, paving breakers, tampers, concrete mixers or other apparatus is necessary, it is ordered to the various jobs so as to keep these machines occupied as nearly as possible full time, and without delaying the other work.

Machines have, of course, displaced a great deal of hand labor, but no new apparatus is purchased until it is clearly demonstrated that a saving can be effected. Ditching machines are used of such size as to handle the work most economically. The backfillers in use are built on a Fordson Tractor, and have demonstrated their ability to refill trench cheaply, and have added advantages in a moving speed of 10 to 12 miles per hour and in being always available for use as tractors with only a few minutes time for removal of boom.

Air compressors are being used to a greater extent each year for

Fig. 1. Danger Signals

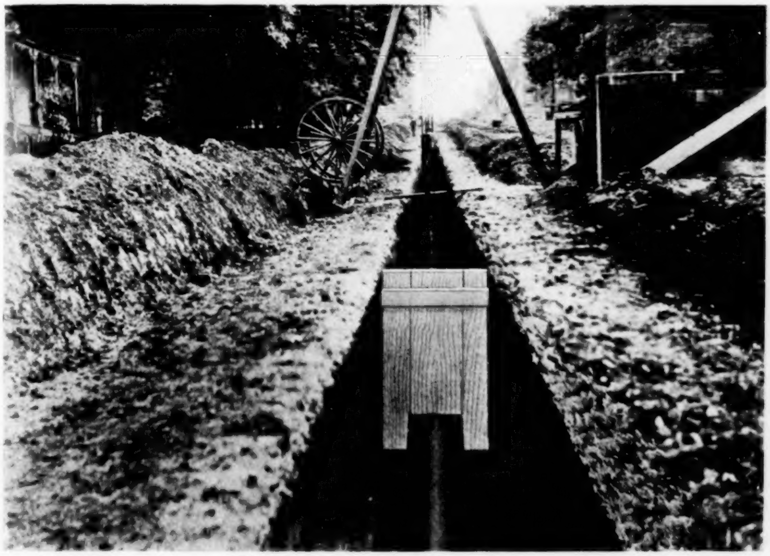


Fig. 2. Trench Bulkhead

breaking paving and tamping refilled material, and it is believed their use will continue to increase.

All machines are operated as independent units both in dispatching and in accounting. Items of cost, including depreciation, operating labor, repair labor, repair parts, gasoline, oil and supplies are accounted for and the cost per unit of work done computed, to be used in figuring prices to be applied the following season.

Close contact is maintained at all times between the heads of the division and the foremen in charge of gangs and operators of special machines. Foremen are urged to obtain low cost without sacrificing quality of work, safety of workmen and safety of the public must be given careful attention, every measure must be taken to guard the convenience and good will of the public.

Proper flushing or tamping of trenches must be done if settlement of paving is to be avoided, and the cost of refilling a trench in an unpaved street due to settlement after the construction gang has gone is always too high. In all possibe cases backfilled material is thoroughly flushed, and for this purpose a pipe nozzle 5 feet long is used on the flushing hose. By this means it has been possible to saturate all refill and to eliminate practically all pockets of dry material which might later settle and cause damage. On steep grades it has not only been found difficult to properly flush trenches, but washing out of material during heavy rains causes a large expense. By building timber bulk-heads at intervals of from 50 to 200 feet this trouble has been largely eliminated, and since these bulk-heads may be made of second hand flooring, ship lap or plank the expense is small.

Since all the work of the Construction Division is upon public thoroughfares, the necessity for the protection of the work so that accidents to the public may be avoided is evident. Barricades painted in patterns to afford maximum visibility are provided and are so designed as to be quickly and securely placed, and be conveniently transported from job to job. Provision is made on these barricades for the attaching of red lanterns in such a manner that they will not be easily displaced. Lantern rods are provided with a large metal flag with the word "Danger" thereon, which serves as a warning during the day as well as a support for a red lantern at night. "Slow—Danger" signs are provided to be set back towards approaching traffic in congested districts, and red flags are provided for use on the ends of projecting loads on trucks.

FIG. 3. FORDSON BACKFILLER

FIG. 4. MAIN TRAILER USED IN INSTALLATIONS OF GAS SERVICES

FIG. 5. TWO-TON TRUCK WITH "MAIN TRAILER"
Trailer has rubber tires, spring suspended, and steel body

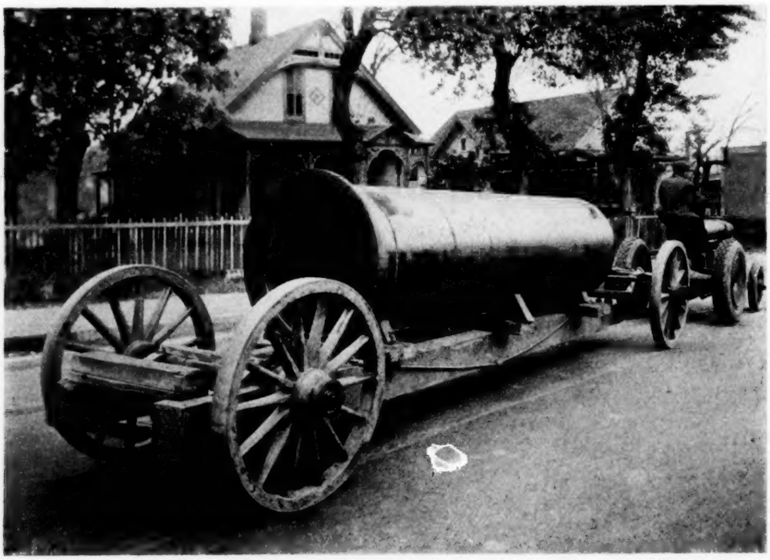


FIG. 6. HORSE DRAWN PIPE WAGON USED AS TRAILER BEHIND TRACTOR

A rule for the placing of red lamps has been adopted which provides lanterns not more than 5 feet apart on a line at right angles to traffic, 50 feet apart parallel to traffic on main thoroughfares and in a congested district, and 100 feet apart elsewhere. Where necessary to open trenches across streets, care is taken to provide the maximum possible width of crossing and every effort is made to refill such excavation at the earliest possible time. Where trenches are in unpaved streets, a small cheap sign painted yellow and bearing the words "Danger—Soft Trench" is placed at intervals of about 200 feet, and has been found very effective in keeping vehicles out of such trenches. These signs are made from $\frac{3}{8}$-inch boxing lumber with a short piece of lath nailed on for a support, are dipped to give the ground color and then stenciled both sides with the words. The cost is about four cents each, and no effort is made to recover them, it being believed that they will remain in position until the trench is safe.

Upon completion of each job a report is made by the field engineer showing every possible item which might at any time in the future be of interest. The location of every special in the line is noted, distances both from property line and from curb, the location of all structures which may be encountered during the work, such as other water and gas mains, telephone conduits, sewers, etc. are shown on the report which is forwarded to the engineering department for posting on the various office records.

Realizing that special training of all men in the division is necessary, if best results are to be obtained, a foremen's school or conference was started about a year ago for the instruction of foremen and others who have supervisory charge of work. These schools are held Saturday afternoon from 2:00 o'clock to 4:00 o'clock and all foremen are required to attend. Matters are discussed relative to the work, information is given as to what progress has been made during the previous week, foremen describe any particular difficulty they have had in the course of their work and what measures were taken to meet it, and a general training course is carried out. Among the subjects that have been discussed are; best methods of doing various classes of work; safety work affecting workmen and the public; first aid, with particular reference to resuscitation from gas asphyxiation and from shock; procedure in case of an accident either to a workman or the public, such as obtaining names of witnesses and data pertaining to the manner in which the accident

happened; attitude of employees toward the public to promote good will, and numerous other subjects brought up either by the management or the men themselves. As an example, one meeting was devoted to a discussion as to the proper shaping of cutting and caulking tools, the proper size and shape of frost and concrete bars, and as a result of this discussion standards were adopted which have not only simplified the work of the tool department, but have caused much better and more uniform equipment to be sent to the men on the job. These meetings are informal and a general round table discussion by the men interested is obtained. Outside features on various subjects pertaining to the work or to related subjects, suitable moving pictures and steropticon views are contemplated in order to give greater diversity to the meetings and to make them more interesting to the men. While some of these foremen are engaged entirely on gas work, others on water main work, and still others handle both classes of work, it has been found that a splendid co-operation has been brought about and that the time spent is very much worth while.

WATER TREATMENT IN OHIO[1]

By W. H. Dittoe[2]

In 1908, Phillip Burgess, a member of this Section, was retained by the State Board of Health of Ohio to make a study of the then existing filter plants in the State. I am sure he will agree that I am correct in stating that when he made his investigation he found that the plants were generally running themselves, very few of them being in charge of men who knew what they were about. Most of the plants were being operated by men who had not the faintest conception of the chemical reactions involved and bacterial removals which were effected in certain operations and the plants themselves were not what we now consider to be modern filtration plants.

However, Mr. Burgess reported to the State Board of Health that mechanical filtration was an efficient means of producing safe water, if a well designed plant was provided and properly operated. After his work was done there was the inevitable relaxation, which is so customary in State work, a withdrawal of operations and practically no follow-up. In the meantime, these plants continued to operate, and in fact, new plants continued to be built and the problem of producing safe water increased rather than diminished.

As years went by, it was recognized that something must be done to improve the operation of plants. It was not until about six or seven years ago, however, that appropriations were made available whereby a proper personnel could be employed by the State Department of Health. After that was accomplished, competent personnel was employed by the Department of Health, and an energetic campaign was instituted to secure improved operation of the filter plants.

After thorough investigation it was decided that the time had come to insist that the cities of the State employ competent men, specially trained, to operate their filter plants. A program of control of operation of filtration plants was adopted and it was determined to adhere rigidly to that program. The program, while it struck the larger plants forcibly in insisting on full-time technical supervision

[1] Presented before the Central States Section meeting, Dec. 5, 1924.

[2] Chief Engineer, State Department of Health, Columbus, Ohio.

of such plants, also struck the smaller plants with probably equal force, by insisting upon daily analytical determinations, so as to see that the water produced was safe. The proposal was met wth considerable encouragement and support, on the part of municipalities. After a few years effort the majority of the plants in the State were manned by men competent to perform their tasks.

Then came the thought, "here is a group of men working for the cities of the State of Ohio, who are daily gaining information that should be exchanged, disseminated, and be made available." So there came about the organization of these men into what has been called the Ohio Conference on Water Purification.

The Ohio Conference on Water Purification is an organization of men employed by municipalities and water companies in supervision of operation of water purification plants in Ohio. The Conference was formed in November, 1921 at the instigation of the State Department of Health. The purpose of the Conference as set forth in its constitution is "to promote the science and practice of water purification, to promote coöperation among the members of the Conference and with the State Department of Health and in this way to enable each municipality to benefit from the experiences of other municipalities." The active membership of the Conference includes those who are employed in the supervision of operation of water purification plants and also engineers in the employ of the State Department of Health. Engineers engaged in the design of water purification plants and others officially interested in the objects of the Conference are eligible as Associate Members. The personnel of the officers and committees of the Conference is made up from the active membership. While the engineers of the State Department of Health are in close touch with the Conference, it has been the policy thus far to avoid selection of any of the State Department of Health engineers as officers of the Conference or as members of committees. The only exception to this rule is the selection of F. H. Waring, principal assistant engineer of the State Department of Health, as editor of the Annual Report which has been published. Thus the Conference stands on its own feet and while it receives assistance and guidance from the State Department of Health, it is in fact an independent and self-governing body.

Four meetings have been held since the organization of the Conference. Each meeting has occurred in November which month has been considered on the whole to be the most satisfactory. Annual

reports have been published by the State Department of Health and have been given wide distribution. While the greater number has been distributed throughout Ohio, requests have been received and reports have been sent to almost every state in the Union and to many foreign countries.

It may be of interest to mention some of the subjects considered at the meetings of the Conference. Details of laboratory practice and of plant operation were given first consideration. The occurrence and detection of phenol in public water supplies was discussed. Limitations of efficiencies and the corresponding question, limitations of loadings of purification processes, have been discussed. The question of bacterial standard of quality of a filter effluent has been considered. The Conference has also discussed size and quality of sand for filtering material; double coagulation; carbonation and other problems of water softening; corrosion, and the treatment of public water supplies with iodine. One of the most interesting phases of the discussions has been the question box which has developed into a presentation of "tricks of the trade." This has afforded a means of discussing unusual and more or less individual problems demanding initiative and resourcefulness for their solution.

It is perhaps true that Ohio finds a conference of this kind of special or particular value on account of the relative importance of water purification in Ohio. Of a total population of approximately 4,000,000 people served by public water supplies in the state, 3,400,000 are served by water supplies which are purified either by disinfection alone or by filtration plants. There are sixty-four filtration plants serving a population of 2,500,000 and twenty disinfection plants serving a population of 900,000. Of the sixty-four filtration plants, thirty-one have full time technical supervision, twenty-seven have part time technical supervision and six are operated without technical supervision. These six plants are small ones. Of the twenty disinfection plant installations, one receives full time technical supervision. The part time technical superivison referred to is given by the superintendent or chemist-in-charge of a neighboring filtration plant and usually includes daily analytical work with visits at intervals of not more than one month.

Before I speak of the results secured, I would like to mention the personnel of these operators in Ohio. The plants are in charge of thirty-seven different men. Of these thirty-seven, twenty-three are expert operators. They are technically trained men who we felt

could leave their particular plants and go to another plant and make good. They did not have to go through a course of training. In addition to the twenty-three expert operators there are fourteen who may be termed competent. These latter are men who have trained themselves in their particular plants, with the aid of the State Department of Health. So there are thirty-seven men, all of them dependable for their particular job and twenty-three of them fully dependable for almost any kind of a similar job.

There are also plants which are receiving part time supervision, and I would like to call your attention to some of these. For instance, the plants at Ravenna and Tiffin, Ohio, are supervised by the superintendent of the Akron plant. The plants at Conneant, Willoughby and Painesville, are supervised by the superintendent of the Ashtabula plant; the plant at Sebring, by the superintendent; at Alliance; the Upper Sandusky, plant by the Bucyrus superintendent; Barnesville, Delaware, and Woodsfield by the man in charge at Columbus; Wauseon by the man at Defiance; Toronto by the man at East Liverpool; Niles, and Struthers by the man at East Youngstown. Huron, Vermillion, and Wellington, by the man at Lorain. Attica, Cedar Point, and Port Clinton, by the man at Sandusky; Lima, State Hospital and Findlay, by the man at Lima; Napoleon, by the man at Toledo.

This results in a quick service system. In most cases these men are within half an hour of the plants which they are supervising. Each has a Ford machine, or perhaps something better, and telephone communication brings them to the plant in a very short time. An hour will suffice to get them on the job, so that this part time technical supervision really amounts to full time supervision, and would be practically equivalent to full time supervision in a large city.

The results secured from the organization of the Ohio Conference on Water Purification have been satisfactory. The meetings have promoted an acquaintanceship between the members and with the engineering personnel of the State Department of Health and have encouraged coöperation which otherwise would have been difficult to secure. Better plant operation and technique have resulted and better general maintenance of the plants has been realized. Naturally this has resulted in the production of better water for drinking purposes. The existence of the Conference has also assisted greatly in promoting the status of the filtration plant and the plant superin-

tendent in the municipality served. This has brought about a willingness on the part of municipal officials generally to accord to the plant and to the superintedent the coöperation and assistance which is necessary to maintain satisfactory plant operation and efficiency. The Conference appears to be a permanent organization which may be expected in future years to produce even more valuable results than it has produced thus far.

PROGRESS OF THE MELCROFT CASE[1]

By C. A. Emerson, Jr.[2]

The Journal of this Association for June, 1925, carried a rather complete résumé of the Melcroft Coal Case in the report of the Committee on Industrial Wastes in Relation to Water Supply. It is unnecessary, therefore, to consider the early phases of these cases in detail.

Briefly, the Pennsylvania Railroad, the Mountain Water Supply Company, and the Commonwealth of Pennsylvania sought to restrain the Melcroft Coal Company and some twenty other coal companies from polluting a water supply from Indian Creek with drainage from various mines on the water shed. The opinion of the County Court rendered on December 26, 1922, was favorable to the coal companies, but the Pennsylvania Supreme Court, in an opinion rendered on September 29, 1924, reversed the decision of the lower court, concluding that the famous Sanderson cases did not apply, and that because of the public use made of the waters, the coal companies had no right to discharge mine drainage into the stream. The United States Supreme Court declined to review the findings.

In conformity with the opinion of the higher court, an order was issued by the Fayette County Court on January 29, 1925, giving the coal companies until July 30, 1925, to cease discharge of mine drainage into the stream.

Several of the smaller coal companies ceased operation, but certain of the larger companies which continued working their mines endeavored by several methods to comply with the order of the Court. Surveys were run to provide a large drainage ditch for collecting the mine waters and carrying them to a point below the Water Company's dam, but it was found that without the right of eminent domain the cost of acquiring the necessary lands would be prohibitive. Wells were drilled to depths of 200 to 300 feet with the hope of reaching permeable strata into which the mine drainage could be discharged.

[1] Presented before the Central States Section meeting, October 9, 1925.

[2] Consulting Engineer, Fuller and McClintock, New York, N. Y.

These wells soon clogged and became useless. Consideration was given to an underground conduit leading below the dam, to consist of a tunnel through the coal measures and pipe lines where the slope of the coal was such that the tunnel would not conform to the hydraulic gradient. Some of the companies are experimenting with treatment of the mine drainage by sedimentation and addition of hydrated lime.

Shortly before expiration of the period set by the Court, the coal companies petitioned for an extension of time of six months, with permission to later request additional extensions, in order to give them opportunity to devise satisfactory ways and means for compliance with the order of the Court. After argument by attorneys, the County Court dismissed the petition on August 10, 1925.

About the middle of September the Attorney General's Department petitioned the County Court to cite the defendants for contempt, and the hearing on this petition has been set for October 19.

These cases have occasioned a great deal of discussion among waterworks men and particularly those in the coal fields.

All seem agreed that in the case of supplies taken from the larger streams, which for many years have been carriers of mine drainage, little or no benefit will accrue, but as applied to supplies taken from streams where mining operations have been started recently, or where the coal measures have not yet been opened, and where conditions closely resemble those on Indian Creek, everyone is equally agreed that some real, but as yet undetermined benefits will be forthcoming.

There is another side to the problem which has been mentioned but little by the waterworks men, and that is realization of the value of the coal deposits. Coal is so vital to the continued prosperity of the nation that we must recognize that it is not reasonable to believe that the decision of the Court in these cases can be so far reaching as to prevent the mining of sufficient areas to cause great economic loss or permanently interfere with the mining industry at large. This may lead to future legislation that will set up some compromise position. In this event it will plainly be the duty of this and similar associations to use such influence as they possess to prevent legislation that would completely nullify the advantages gained so far through these historic cases.

INCREASING THE CAPACITY OF GROUND WATER SUPPLIES[1]

By W. G. Kirchoffer[2]

This paper deals mainly with water supplies derived from wells, both deep and shallow. For convenience, I have divided the subject matter into eight different headings.

1. WELLS IN ROCK FORMATIONS

These are usually relatively deep and of small diameter.

a. Such supplies especially when there are two or more wells in use can be increased in capacity by reaming out to a larger diameter. Examples of this method were tried out at De Pere and Whitewater with very good results. Coupled with reaming is recasing. Often the old casing has rusted out or never was properly set.

b. Where the distance down to rock is relatively great and it would be expensive, if not hazardous, to attempt to ream the wells they can be shot with dynamite or nitro-jelly in quantities of 5 to 75 pounds.

Shooting does little or no good if not done in a waterbearing formation. That is, if the shooting is done at any depth regardless of the formation, the well may be damaged more than it is improved. During the last four years over sixteen wells have been shot in Wisconsin, mostly city and state wells with some very remarkable results. At Waupun two wells at the Prison and Central State Hospital were shot three to four times with shots varying from 25 to 50 pounds, with the result that the specific capacity of the wells were increased 1000 per cent. At Watertown a well that had been next to useless was shot four times, loosening up about a whole carload of sand and making the well a valuable addition to the city supply. Occasionally the results are not as favorable. A well in

[1] Presented before the Joint Sessions of the Iowa, Illinois and Wisconsin Sections, March 17, 1925.

[2] Sanitary and Hydraulic Engineer, Madison, Wis.

Madison was shot several times in what is known as the Eau Claire formation with the result that each shot only increased the supply about 5 per cent. This was not the fault of the shooting, but because there was no other formation present to shoot. Where detailed records are not available the services of a geologist may assist in determining the proper depth to shoot.

c. It often happens that wells are not drilled deep enough to penetrate all or the best water bearing formations. If there is only one well, it cannot very well be taken out of service to drill it deeper, but where there are several wells this can be done.

At Sun Prairie, Deerfield, Mauston and Tomah, shallow wells have been in use where there was plenty of good waterbearing rock below that could be penetrated. Recently a well at Tomah was put down to a depth of 320 feet and yields as much or more water as the three old 150-foot wells do. It sometimes happens that the quality of the water changes with the depth and that deep seated waters are more highly mineralized than are the waters from shallow wells. On the other hand, some shallow well waters contain much iron which is objectionable from many standpoints. These matters should be taken into consideration before deepening the wells.

d. It used to be and is now a quite common practice to case a well only down to rock and leave the none-waterbearing rock exposed in the well to take water instead of yielding it. This is particularly true where the well is non-flowing, but still penetrates strata that are under pressure. Wells that at one time flowed and have since ceased, have done so principally because the water has escaped in the crevices of the open non-waterbearing rock or if packed, the liner has rusted out.

It is quite a common practice now to drill a well of a somewhat larger diameter down to the water level or to the depth where the water begins to rise in the well and then grout a casing into that level.

e. It is a well known fact that wells if placed too close together will interfere with each other. This is shown by a reduction in the capacity for a definite suction lift or by a greater lowering of water where the quantity pumped is the same. Under ordinary suction lifts wells interfer but little when spaced 400 to 600 feet apart, but if they are pumped by air lift or other means, where the lowering of the water is great, the interference will be relatively large and will be appreciable in the capacity of the system.

Where isolated pumping stations are used and pump directly into the mains, the element of cost does not enter into the consideration of spacing, but where the wells are operated in one system or "gang," discharging into a common reservoir at the station, the economical spacing is dependent not only on capacity, but on the overhead cost of operation due to the greater investment involved for a greater spacing.

2. WELLS IN LOOSE FORMATIONS, BUT RELATIVELY DEEP AND OF SMALL DIAMETER

Such wells are usually drilled or bored and obtain their water through a screen usually of metal. Such screens clog readily with sand and with the mineral compounds deposited by the water. Such supplies can be increased or brought back to their original capacity by:

a. Back-blowing with air, brushing out and washing, a good example of this sort of treatment was at Wausau and the Marathon Paper Mills where the capacities were increased and the suction lift materially reduced.

b. By pulling the screen and replacing it with a new one.

c. By substituting a new gravel packed well, if not too deep.

3. WELLS IN A FINE SAND OVERLAID BY IMPERVIOUS MATERIALS, WATER UNDER PRESSURE SUFFICIENT TO PRODUCE A FLOW OR RAISE THE WATER NEAR THE GROUND LEVEL

It has been customary in this country to treat such formations the same as we do all other sand and gravel waterbearing strata namely use a well screen.

a. In India they make a well called "Mota," meaning cavity. They drill or bore a hole through the impervious materials and case it just to, but not into, the fine sand. They then pump at a high rate until all of the sand that will rise due to that velocity or rate of pumping will come out. This produces a "cavity" under the drill hole in the fine sand, sufficient to supply water at a given rate without drawing sand. The city of New London has a few such wells.

b. This type of well could be modified and greatly increased in capacity by drilling a gang of wells around a large central well

and then applying fine gravel to the outer wells while pumping sand from the central one. This will fill the cavity with gravel and at the same time make a bigger one.

4. WELLS IN SHALLOW FORMATIONS OF LOOSE MATERIALS, SUCH AS SAND AND GRAVEL AND OF RELATIVELY LARGE DIAMETERS

a. Driven wells of small diameter with metal screens. These wells are usually short lived and never should be replaced of same construction, but use some of the other methods hereafter outlined.

b. Tubular wells. These wells are slightly better than the driven wells, for the screen is definitely placed in good water-bearing materials if they exist at the location. This type can be increased in capacity by the back-blowing process or by pulling screen. However, it would be preferable to use some of the more modern type of wells.

c. Wells of relatively large diameter, with gravel packing or strainer about a coarse metal screen. Where a source of supply is now from sand and gravel formations and is inadequate one of the most effective and economical methods of increasing the supply is to use this type of well. There are various methods by which it can be done, but one of the common methods is to sink a large cylinder or casing down through the waterbearing formation, insert a screen with large openings, but of smaller diameter than the bored hole.

The space about the screen is filled with screened washed gravel of proper size for the particular location. When this is down, the larger casing is drawn up to the top of the screen.

Another method is to use a screen with a big shoe attached to the bottom of it of sufficient diameter to carry down a ring of gravel sufficient to properly pack the well. The amount and size of gravel depend upon local conditions of water bearing strata.

d. Another modern method of increasing a supply from loose materials near the surface is to use a circular concrete wall with porous concrete screens set in the side walls. The shoe is made two to four feet larger all around than the outside of the wall. This is sunk by the use of a sand sucker pump, clam shell or orange peel bucket, as the wall sinks the gravel packing is applied to the outside of the wall upon the shoe. A good example of this type of well was

recently put down at Waupaca. The well is 30 feet in internal diameter, 41 feet in external diameter and 30 feet deep. It has a capacity of 900 g.p.m. for a lowering of 8.9 feet. A similar well in coarse gravel formations, but without the shoe or gravel, is the principal source of supply at Delavan.

5. SPRINGS FROM ROCK

Usually deep seated springs must be found not created, as are wells and other types of supply. When they are available they can be greatly increased by creating a large cavity or reservoir about the apparent opening and by so arranging the pumps so that the water level in the reservoir or spring wall can be lowered several feet.

An example of a large spring supply may be found at Lancaster, Wis.

6. SPRINGS OR SEEPS FROM SHALLOW FORMATIONS

These are either from sand and gravel formations overlaid by impervious materials where the water is under pressure and finds its way to the surface or they are at the intersection of the ground water table and the surface of the ground where the water table "outcrops" along some valley.

Such supplies can be increased by applying any of the methods used for shallow loose waterbearing materials or by a porous pipe line laid in washed gravel or by any of the types of infiltration galleries.

7. SUB-SURFACE DAMS ACROSS VALLEYS

a. It often happens that there is an underflow of a small stream at or near the water supply, but in too shallow or too fine a sand to make a water supply by any of the above methods, but if the entire underflow was caught, the supply would be adequate or could be increased by impounding the creek waters back of the dam and causing it to seep into the waterbearing formation below.

An example of this sort of a supply is found in the new supply at Black River Falls where they are building a hollow dam with porous concrete screens in the side walls and a four foot shoe at the sides. The dam is being sunk in sections 16 feet long by 8 feet wide with 4 feet sloping shoe on each side. Upon the shoe or apron,

are placed the rows or layers of coarse sand, roofing gravel and coarse gravel.

The water bearing sand is extremely fine, so a layer of coarse sand is placed next to it, then the roofing gravel and finally the coarse gravel next to the screen. The dam when completed will be 128 feet long by 18 feet 6 inches high. A spillway will be so arranged that the creek can be impounded any depth up to 4 feet which will make quite a lake above the supply. It is estimated that the natural supply from the underflow will be 432,000 gallons per day, but can be increased as the city's needs increase by raising the crest of the spillway.

8. PROSPECTING FOR A NEW ADDITIONAL SUPPLY

What has already been said can readily apply to a case where there is an existing supply, that is, definite knowledge is had of the existence of a ground water source either from previous development or by information supplied from other sources. However, there are cases where the existing supply has never been adequate, although various attempts have been made to increase it. Or there are cases where, for instance, a city has been pumping river water and wants to secure an adequate ground water supply. The question arises what procedure should be taken to secure such a supply.

The procedure now taken in many cases can be divided into three classes.

a. Where the city, under the direction of the superintendent of waterworks, local well driller or college professor, attempts to develop an additional supply without scientific investigation as to quality, quantity or method of development.

b. Where a water supply development company comes in and offers to guarantee a definite quantity of water for a predetermined price. No water, no pay; any water, big pay.

c. Where an engineer or specialist in underground waters is called in to locate a place for the new supply or to direct the prospecting, if it is advisable to do any. Samples of the waterbearing materials are studied for waterbearing qualities and for the probable quality of water they will produce. When a desirable site is found to make a pumping test that will show what the capacity of the formation is to produce water and what type of well is best suited to the local conditions.

Method (*a*) might be the cheapest if the parties are successful in locating a new supply and use proper design and methods of construction, but if they did not, it may be the most expensive, and, as has happened in some cases, a complete failure.

Method (*b*) has this advantage for the city, they do not have to pay for the prospecting work if no supply is found or if the water supply company does not see fit to carry out their part of the contract, because they usually reserve the right to pull out any time they like. If they are successful and carry out the work, it may be expensive for the city. In some such contracts enough attention is not paid to doing the thing legally and to properly protect the city's interest as to quality of water, presence of iron and hardness.

The location and design of the plant are left entirely to the development company which may or may not be a good thing for the city. With this method no adequate competition can be had upon the construction of the plant, as many contractors will bid only on plans and specifications prepared according to law and property adopted by the city authorities.

Under Method (*c*) the city has everything to gain and little to lose. They will have to pay for the prospecting work and for the engineer or water specialist fees. If they select the right man for the place he will find them a supply, even if he has to catch raindrops to do it.

I have known of cases where a water supply engineer had located a supply within a couple of miles of a city simply by his knowledge of the geology of the region and because he knew that water bearing gravels existed usually only on one side of a terminal moraine and on a certain side of the river.

So far we have discussed the source of supply. It often happens that the supply is naturally adequate, but the difficulty lies in the location, elevation or method of pumping. Supplies may be made adequate at least for a time by one or more of the following methods.

a. Substitution of vertical shaft, centrifugal pumps placed in the well so as to effect a greater lowering of the water.

b. Substitution of air lift pumps for other types of pumps or more efficient air lifts for inefficient ones. At Clinton, Wis., shooting of the well and the installation of an efficient air lift for an inefficient one saved the village $1700 per year in their pumping bills.

c. Where suction pumps are used they are often too high above the water so that the pump cannot draw the water in sufficient

quantities. The placing of the pump in a pit or basement often produces the desired result.

d. The substitution of deep well triplex or vertical turbine pumps where a shaft or pit can be sunk will often increase the supply without additional wells.

e. Where the source of supply is from a flowing well or where the water rises nearly to the surface, a reservoir can be added so as to allow the well to flow continuously regardless of the rate or time of pumping.

PROBLEMS OF HARD AND SOFT WATER[1]

By Ross A. Thuma[2]

The question of hard water as a municipal water supply as opposed to that of softened water has been under consideration at the St. Paul water purification plant for more than two years. We have investigated the problem of water softening from many different standpoints, such as, health, plant operation, economy, utility, etc. The purification plant was operated as a softening plant during the month of January, 1925, for the purpose of determining whether it would operate as such. While the period of one month may be too short to form a definite conclusion, our experience was of such nature that we feel confident that the plant would function as a softening plant. Our difficulties were, however, of a different nature, namely, that of convincing the public that softening treatment was worth while. The two questions which seemed to be uppermost in the minds of the citizens were, first, will the softening treatment be in any way injurious to health, and second, will there be sufficient savings to warrant the installation of the softening process? While the value of water softening may be considered from many angles, we shall show that there is no probable danger to the health of the water consumer from the use of softened water, and that the returns on the investment from water softening are, indeed, generous. Furthermore, we shall endeavor to show that water softening is a question of economy and utility, and not a question of heatlh.

WATER SOFTENING IN RELATION TO HEALTH

If one will refer to Water Supply Paper No. 496, United States Geological Survey, by W. D. Collins, he will find the following data. The United States Geological Survey have divided the country into four sections on the basis of the water hardness.

The first division includes the section of the country which has water of a hardness of from 0 to 55 p.p.m. or the soft water area. This territory includes

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[1] Presented before the Minnesota Section meeting, November 13, 1925.

[2] Superintendent of Filtration, Bureau of Water, St. Paul, Minn.

the northeastern section of states, New York, the states bordering on the Atlantic and Gulf Coast to Texas and with the exception of Florida, and the states of Oregon and Washington. In this soft water section of the country there are more than 17,000,000 people using soft water.

The second division includes the section of the country which has water of a hardness of from 56 to 100 p.p.m. or the medium soft water area. This territory includes the second tier of states from the Atlantic coast and the states of Montana, Idaho and Nevada. More than 5,000,000 people in these states drink medium soft water.

The third division includes the section of the country which has water of a hardness of from 101 to 200 p.p.m. or medium hard water area. This territory includes the following states; California, Wyoming, Utah, Colorado, New Mexico, Texas, Arkansas, Missouri, Ohio, Michigan, Wisconsin, Minnesota and North Dakota. More than 11,000,000 people in this section drink medium hard water.

The fourth division includes the section of the country which has a water of a hardness of from 201 to 500 p.p.m. or hard water area. This territory includes the states of Arizona, Oklahoma, Kansas, Nebraska, South Dakota, Iowa, Illinois, Indiana and Florida. More than 5,000,000 people drink hard water in this section of the country.

There are then in the United States more than 23,000,000 people who drink water of 0 to 100 p.p.m. hardness with apparently no ill effects. There are more than 16,000,000 million people who drink water of more than 100 p.p.m hardness with no ill effects. We would, therefore, be forced to conclude that the hardness of the water exerts no apparent physiological effect upon the water consumer.

Water softening removes two elements from the water, calcium and magnesium. The body requires for its growth and development about fifteen of the chemical elements. If we must look to our food supply for thirteen of the fifteen chemical elements needed for the upbuilding of the body, why not include the other two in the food requirement? Without going into the details of the matter, we believe that the average diet that will furnish the other elements will furnish, also, the necessary requirement of calcium and magnesium. In view of the above facts, we believe that it is obvious that water ought not to be used for the food elements it contains, but rather as drink.

The taste of water is one of the things which plays an important part in deciding the character of a water supply from the standpoint of the consumer. When one has accustomed himself to drinking water of a given hardness he will dislike the taste of water of a different hardness. A difference in hardness of 25 to 40 p.p.m. is noticeable. In view of the difference in taste due to difference in

hardness, it would seem that the water department would place itself at an advantage by serving water of uniform hardness. The St. Paul water supply varies in hardness from 135 to 225 p.p.m. during the year. By softening the supply to a given hardness, say of from 85 to 100 p.p.m., the objections from change in taste due to change in hardness would be eliminated.

THE COST OF SOFTENING WATER AS DETERMINED AT THE ST. PAUL PLANT

It is a comparatively easy matter to estimate the cost of softening a water of known hardness. The benefits to be derived from such work are particularly difficult to calculate. However, from various estimates derived from the use of soft water, we believe it is well worth while. In this paper we will consider the cost from the viewpoint of increased cost in chemicals. Our working force remains the same whether we soften the water or use aluminium sulfate.

The water during the month of January, 1925, had a hardness of 180 p.p.m. We will base our estimates on the reduction of the hardness to 85 p.p.m. This would require a reduction in hardness of 95 p.p.m. In order to reduce the hardness to the figures given we used lime of 90 per cent available calcium oxide, at the rate of 137 p.p.m. and ferrous sulfate at the rate of 17 p.p.m.

We did not have facilities for recarbonating the softened water for eliminating caustic alkalinity. The caustic alkalinity averaged for the month 27 p.p.m. Recarbonation is necessary in case softening is to be made a continuous process. When recarbonation is practiced there is no danger of after-precipitation of lime on the sand grains, pipe lines, meters, and the alkalinity of the water is under control. We can regulate the reaction of the water within narrow limits to the convenience of the requirements. On the cost of recarbonation we will quote from the experience covering over a period of three years at the Defiance, Ohio, water plant.

For recarbonation of the softened water to eliminate caustic alkalinity, on the average, of 42 p.p.m. and leaving the water charged with $2\frac{1}{2}$ p.p.m. free carbon dioxide as practiced at the Defiance plant. The carbon dioxide is generated from the burning of coke in a small furnace. They figured coke at $12.50 per ton for use in generating the carbon dioxide. The net cost was $1.30 per million gallons of water carbonated.

The permanent hardness of our water supply is too low to require the use of sodium carbonate.

The cost of softening a million gallons as required at the St. Paul plant may then be tabulated as follows:

Cost per million gallons for lime—137 p.p.m. rate of $12.00 per ton f.o.b. plant	$6.59
Cost per million gallons for ferrous sulfate—17 p.p.m., rate $18.40 ton f.o.b. plant	1.32
Recarbonation as at the Defiance plant	1.30
Total cost of softening 1 mil. gals. of water	$9.21

If the cost of treating the same amount of water with aluminium sulfate is deducted from the total cost of softening we would then have the net cost of softening. The cost of treating 1,000,000 gallons of water at the rate of 34 p.p.m. and at the rate of $26.60 per ton f.o.b. plant is $3.80. Deducting this amount from the cost of softening 1,000,000 gallons of water, we have a net cost of softening per million gallons—$5.41.

THE VALUE OR RETURN FROM WATER SOFTENING

The soap saved by the use of softened water is a direct measure of its value. Since the soap consuming power of the water is one of the factors most easily calculated and verified, it will be given first consideration. If we refer to Whipple's formula for soap saved by softening water, we find that for a reduction of 95 p.p.m. hardness, we would decrease the soap requirement of the water equivalent to 21 pounds per thousand gallons. Equivalent to 21,000 pounds per million gallons of water used with soap. Obviously not all of the water softened would be used with soap. We believe, however, that an estimate of 5 per cent of the water softened would not be excessive. This would include water used for laundry, lavatory, dish washing, scrubbing, etc. Figuring soap at 10 cents a pound, which is probably below the average cost, we may then calculate as follows:

21,000 pounds of soap at 10 cents per pound	$2100.00
5 per cent of this amount water used with soap	105.00

Our savings on the cost of soap to the community would be enough to justify the expence of softening the water. To this should be added, also, a utility factor, since soft water is more useful than hard water.

THE SAVING OF FUEL BY SOFTENING A WATER SUPPLY

A great deal has been written and said about the savings in fuel from the use of a softened water for boiler purposes. On this point we have nothing definite. However, an estimate of this saving may be made.

It has been estimated by various authors that a savings of at least 5 per cent may be made by the softening of boiler water supply. S. S. Strout, writing in This Journal (vol. 12, no. 4, 1924) on "Softening of Public Water Supplies" with special reference to San Francisco, declared that 5 per cent of the fuel could be saved by softening the San Francisco water supply. As a basis for comparison and cost estimate we will consider that 5 per cent of the coal used in the City of St. Paul might be saved by softening the water supply. There was used in the city during the year of 1923 about 1,550,000 tons of coal and coke for fuel purposes. If we estimate it at a cost of 10 dollars per ton, we could then calculate that the loss on coal from the use of hard water would be:

75,000 tons of coal @ $10.00 per ton	$750,000.00
On the daily basis	2,050.00

During the year of 1923 the average amount of water used was about 20,500,000 per day or for each 1,000,000 gallons of water—$100.00.

OTHER REASONS FOR SAVINGS FROM SOFTENING WATER

Our experience at the St. Paul plant indicates that a larger amount of water could be filtered when the water is given the softening treatment than when treated with aluminium sulfate. For example, when the water was softened our filters filtered on the average 6,400,000 gallons of water for each filter washed, while during the year of 1924 the average amount of water filtered for each filter washed was 4,076,000 gallons.

In lake water where the algae are apt to be high during the winter months softening treatment has the advantage of precipitating the algae and rendering them less troublesome.

In water high in organic matter, either in a highly dispersed condition or in solution, softening has the advantage of removing more of the organic material and thereby cutting down the chlorine requirement.

By softening and recarbonating the water supply it would be possible to keep the water very near the neutral point and thereby to reduce corrosion to the minimum.

Less frequent shut-down of boilers for repair, less loss from blow off water, less boiler upkeep, less labor and repair, less cleaning of scale, and less cost for boiler compound would also result.

COLON BACTERIA IN SOME FISSURE SPRINGS OF THE BALCONES FAULT ZONE

By I. M. Lewis[1]

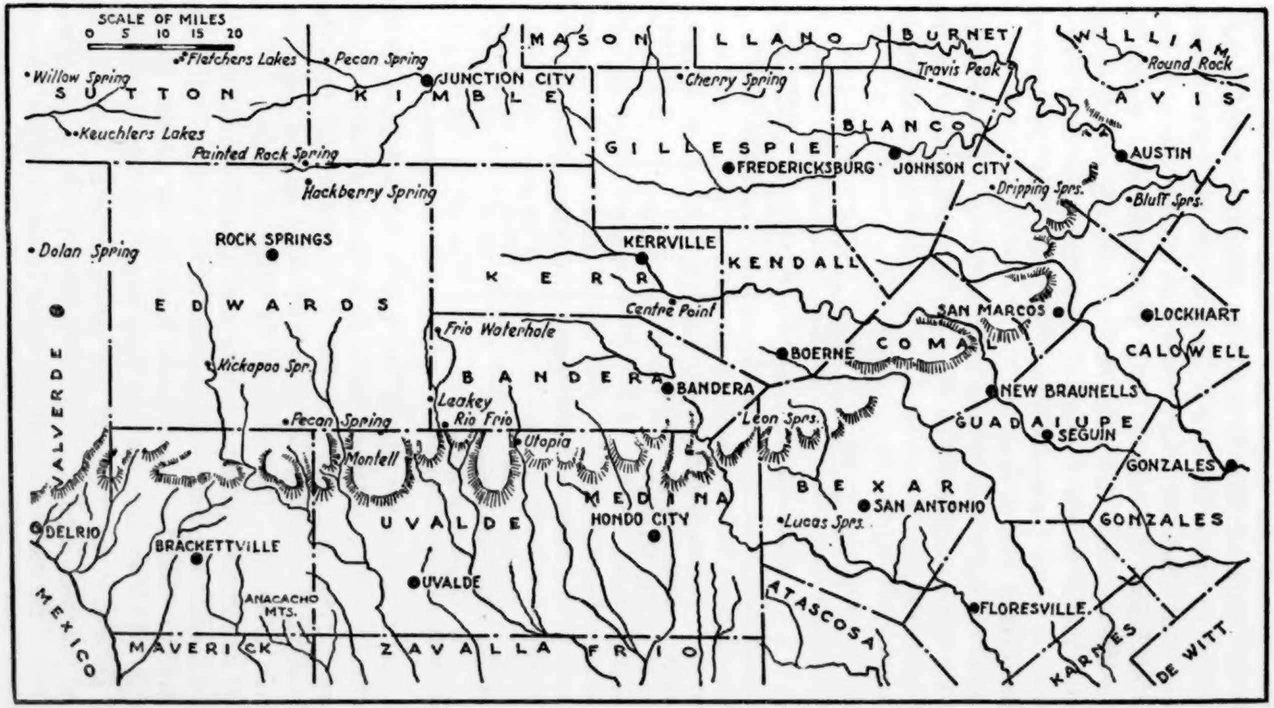
Two of the most important geographic divisions of North America are the Great Plains which occupy the interior of the continent and the broad Coastal Plain which extends along the Atlantic and Gulf Coasts.

To the north, these two divisions are far apart and separated by the Mississippi Valley, the Appalachian Mountains and other geographical provinces. In Texas, the most southerly division of the Great Plains known as the Edwards Plateau and the portion of the Coastal Plain lying farthest west, the Rio Grande Plain, converge and lie side by side. The meeting of these two areas taken place along the Balcones fault line which marks the southern boundary of the Great Plains.

The geology of this region has been extensively studied by Hill and others (2) with special reference to the problem of underground waters. The Balcones scarp zone is easily followed from a point a few miles north of Austin, Texas extending in a generally southwestern direction to a point where it meets the Rio Grande in the vicinity of Del Rio, a distance of over 250 miles. (See map of the area.) The springs in question occur along the northern margin of the plain and coincide almost exactly with the Balcones fault line. Hill points out the fact that these springs are "associated with the system of joints and fractures accompanying the fault line and that their waters come from deep seated rocks and are forced to the surface by hydrostatic pressure. Hence they are artesian in nature and constitute natural artesian wells." He also concludes from a study of the temperature of the water, its similarity in taste, color and chemical content, that "the springs are all of similar origin and that the water is derived from the 'sweet water' horizon of the Edwards limestone or Travis Peak sands."

The temperature of the water, about 71°F., is approximately the

[1] The University of Texas, Austin, Texas.



Map Showing the Relations of the Edwards Plateau, the Balconies Scapr Line, and the Rio Grande Plain

The hachured line is the Balconies escarpment; the Edwards Plateau is to the north of it, and the Rio Grande Plain is to the South.

same as the mean annual temperature of the air in this part of Texas 68° to 69°F. Since normally 50 to 60 feet of depth corresponds to 1 degree change in temperature, it is obvious that the water bearing formation, from which the water comes, can not be located at any great depth below the surface. The great volume of water delivered by these springs and their relative constancy of flow during prolonged drought or heavy rain fall show that their chief source is a formation which transmits water freely and that the reservoir supplying them is vast in extent.

Data as to the daily flow of these springs over an extended period of time are not available. The Division of Hydrography of the United States Geological Survey, however, made measurements of

TABLE 1

Discharge of the various spring rivers

DATE	STREAM (FISSURE SPRINGS)	DISCHARGE IN SECOND FEET	DISCHARGE IN GALLONS IN 24 HOURS
1895			
December 18	Barton Springs	25.0	16,157,921
December 18	Dam Springs, Austin	4.3	2,800,000
December 19	San Marcos	89.0	57,522,200
December 20	Comal	328.0	211,981,932
December 21	San Antonio	42.0	27,145,308
December 21	San Pedro (of San Antonio)	9.0	5,816,852
December 24	Los Moras Spring	21.0	13,572,653
December 24	Del Rio Ditch	19.0	12,280,021
December 24	San Felipe Spring	80.0	57,705,350
	Guadalupe River	48.0	31,023,210

the principal spring rivers during the month of December, 1895. The results are shown in table 1 taken from Bulletin United States Geological Survey, No. 140, page 86. It is safe to say that the average annual flow would not show any very marked variation from these amounts. The question of ultimate source of this water and its sanitary quality has long been a point of interest. A favorite explanation given by inhabitants of the territory in which springs occur is that the water comes from the far distant Rocky Mountains. This explanation has been shown by Hill to be untenable, since the continuity of the strata between these spring rivers and the mountains is completely severed by the valley of the Pecos River. He concludes that the water comes from the Plateau of the plains and its adjacent borders. The area of this catchment

basin is thousands of square miles and its average annual rainfall is 30 to 35 inches per year. Since the nature of the geological formation is limestone, which permits rapid percolation of water through numerous fissures and honeycombed structure, it is obvious that it is capable of supplying vast quantities of underground water. It is also true that much of the run-off water which accumulates in rivers and creeks subsequently disappears at numerous points and adds to the sum total of the ground water.

The sanitary quality of the water has always been considered excellent and it has been used for drinking water, domestic purposes, watering of domestic animals, and in some cases for irrigation. The springs are far-famed for their beauty. The water does not break out from bluffs or fall in cascades as do some of the gravity springs of the plateau country, but rises to the surface forming deep pools which are in reality small lakes of limpid blue water which find their outlets in swift and silently flowing streams.

Barton Springs located at Austin has not been used as a source of municipal supply, but has always been the chief pleasure and swimming resort for the city and surrounding territory. An extensive municipal park has been laid out with modern bath house and the natural beauty has been enhanced by ornamental landscape gardening. The water used in the park is taken from one of the springs and to guard against any dangers to the public health this water is treated by means of liquid chlorine. During the hot summer months thousands of persons visit the springs daily to bathe in the cool invigorating water.

The large group of springs at San Marcos produces a lake more than ½ mile long and of great scenic beauty. The outlet of the lake is the San Marcos River, a beautiful clear stream in which objects may be seen lying on the bottom at a depth of 15 or 20 feet. Aquatic plants frequently grow submerged several feet in the water procuring plenty of light, so transparent is the water. The river furnishes the city water supply, water for the ice factory, for the United States Government fish hatchery and two extensive bathing resorts.

The largest of the springs of this region occurs at New Braunfels and forms the source of the Comal River which flows over 200,000,000 gallons of water per day. One of the numerous springs has been capped and furnishes the municipal water supply.

The springs in the vicinity of San Antonio formerly flowed large volumes of water, but the flow has been somewhat decreased by the sinking of numerous artesian wells to supply the city.

Following the fault line farther west a spring of notable size occurs at Fort Clark, 125 miles west of San Antonio. The last of the series are the San Felipe Springs near Del Rio. Hill says of this spring:

"From the deep-seated rock at its bottom the water can be seen welling up in a great column, and has the same peculiar greenish-blue color as that of the other springs of this class. No trees surround it; it is alone—a fountain in the desert The outflow from the pool forms a bold, rushing stream that runs off to the Rio Grande some 5 miles distant."

So far as the writer is aware no extensive bacteriological studies have ever been published on the waters from these springs. It has not been possible in the present investigation to procure samples from all of them in sufficient numbers to establish conclusive results for the entire series. However, the analyses of water from Barton Springs at Austin have been carried out over an extended period of time, and the data obtained are sufficient to warrant definite conclusions as to its purity, based on methods now employed in the standard methods of water analysis and the standards set by the United States Treasury Department.

During the past ten years, the water of Barton Springs has been analyzed numerous times by students in the bacteriology classes of the University of Texas. These analyses have always shown that the water has a very low bacterial count, rarely reaching as many as one hundred bacteria per cubic centimeter when grown on plain extract agar at 37°C. As to the presence of lactose fermenting bacteria, the results have been variable, but more often the samples have been positive and members of the colon group have been isolated on many occasions. During the past year, a more extensive investigation has been carried out on the water of this group of springs than had heretofore been made.

Samples were collected daily for a period of thirty days from each of the three principal outflows of the Barton series. These samples were analyzed immediately after collection. The samples were taken in sterile glass stoppered bottles at points where the water rushes up out of the rock fissures. There is no possible source of surface pollution at these points. Total plate counts were made from each sample on plain extract agar incubated twenty-four hours at 37°C. Fermentation tubes of lactose peptone broth were inoculated with five 10-cc. portions of each sample and incubated twenty-four to forty-eight hours at a temperature at 37°C.

From each of the positive fermentation tubes inoculations were made to Endo agar using the modified formula of Levine (3) except that Witte's or Merck's peptone was used. The fermentation tubes were well shaken and one loopful of the broth was streaked over the surface of the plate. By this method numerous well isolated colonies were obtained on at least one half of each plate.

The Endo plates, when positive, were very characteristic. The diffusion of the red color is not marked on the part of the plate where the colonies are well separated. The colonies are luxuriant and have a red halo around them within eighteen hours. On this medium, it is not difficult to distinguish the Escherichia section of the group from the Aerobacter section with a high degree of certainty. Escherichia colonies are not so large; they differ in elevation, being

TABLE 2

Results from three of the Barton Springs, Austin, Texas, from daily samples for a period of thirty days

Spring number	Samples tested	Average plate count	Positive fermentation tubes out of 150	Positive on Endo agar	Estimated Escherichia colonies	Estimated Aerobacter colonies	Cultures isolated	Per cent Escherichia	Per cent Aerobacter
1	30	25	114	97	85%	15%	50	79	20.3
2	30	26	111	93	80	20	51	78	21.4
3	30	27	118	98	85	15	53		20.4

more flat and they soon develop a beautiful metallic sheen which is not present on the colonies of Aerobacter. All positive Endo plates were carefully examined to determine the relative numbers of these two types of colon colonies. It became evident, after a few samples had been tested, that the Escherichia type is much more common in these samples than the Aerobacter type. This finding was later confirmed by a study of cultures isolated from the plates. Many of the plates produced only colonies of the typical Escherichia type, while others showed both types of colonies. There were also occasional colorless or pinkish colonies which proved to be non-lactose fermenters and some of the Endo plates failed to develop any colon colonies. In no case did the colonies of the Aerobacter type predominate.

Cultures were isolated to plain agar slants. Not more than one culture of each type was isolated from any one plate, and not more than two from each sample. After growth on the plain agar slants all cultures were re-streaked on agar plates and single well isolated colonies were then fished again to plain agar slants. So far as could be ascertained by means of the Gram stain all cultures employed in the subsequent differential culture work were pure cultures.

The cultures thus isolated were tested as to their ability to ferment lactose with formation of both acid and gas. A total of 154 such cultures were obtained. These cultures were separated into two groups by means of the Voges Proskauer and methyl red test, using the medium of Clark and Lubs and an incubation period of five days at 30°C. As was predicted from a study of the colony characteristics, the Escherichia group predominated over the Aerobacter group. There was a surprisingly high percentage of correlation between the two reactions. Very great care had been exercised to insure purity of the cultures which according to the results of others is an important factor in the correlation. Of 154 cultures tested, 32 cultures or 20.7 per cent gave a positive test for acetyl methyl carbinol. The cultures which were positive in this test were negative in the methyl red test with two exceptions. These two were positive in both tests. The Voges-Proskauer positive colonies all fermented sucrose and glycerine with both acid and gas and are, therefore, classified as belonging to Aerobacter aerogenes. The remaining 122 cultures were grown in sucrose for further separation of the group. Of 122 cultures tested in this sugar 75 were positive. Some difficulty was experienced in definitely placing these sucrose positive organisms. When tested for motility and cultured in salicin, there was considerable discrepancy in the results as recorded. Many of the organisms of undoubted motility failed to ferment salicin with formation of either acid or gas.

Classing all motile sucrose fermenters as Escherichia communior, 69 cultures or 57 per cent of the Escherichia section, 44.8 per cent of all cultures, belong to this species. The remaining sucrose fermenters, 4 per cent which were non-motile were further differentiated by means of salicin fermentation. The cultures which did not ferment sucrose were differentiated by growing in salicin. All positive cultures are classed as E. coli, negative as E. acidi lactici. There were 19 per cent of the cultures in this group which belong to the species E. acidi lactici and 11 per cent which belong to the species E. coli.

It is obvious that this classification does not bring out the variants of the group, but this was not deemed essential in this particular case since the primary object was to determine the incidence of the two main divisions. It is well known that as additional tests are applied the group can be broken up into many different types. As classified by this more simple grouping the results may be summarized as follows:

Total cultures	154
Aerobacter section	32 or 20.7 per cent
Escherichia	122 or 79.3 per cent

The distribution by species follows: Aerobacter, 20.7 per cent; E. communior, 44.8 per cent; E. pseudocoscoroba, 4 per cent; E. coli, 11 per cent; E. acidi lactici, 19 per cent.

DISCUSSION OF RESULTS

The results of this investigation are somewhat surprising, in that it would seem logical to expect a higher percentage of the Aerobacter section of the colon group in waters of this quality. There are not, however, many data at hand with which to compare these results and the results of others on similar waters. The work which most nearly approaches it and to which the results may be most appropriately compared is that of Winslow and Cohen (8). These workers isolated colon bacteria from waters of known sanitary quality in the vicinity of New Haven and found that the percentage of Voges Proskauer positive organisms did not differ markedly in polluted, unpolluted and stored waters. The percentage of Aerogenes strains was moreover about the same in the stored waters as has been found in the present case.

These results also approximate very closely the findings of Elinor Rogers Houston on some ground and surface waters in the vicinity of Austin, Texas. This investigator during the season of 1923 studied the incidence of colon bacteria in 91 samples of water. These samples were obtained from a variety of sources which may be divided into two groups on the basis of probable pollution. The first of these consists of 23 samples where pollution might have occurred and the remaining 58 were from sources not polluted, so far as could be determined. These samples might also be grouped according to the kind of source, as follows: 32 from shallow wells, 35 from springs, 8 from small streams, 4 from the Colorado River, 4 from

pits dug in the sand several feet from the rivers edge, 3 from the city tap water, 3 from tanks and 2 from deep wells. In testing these samples, 23 proved to be negative for lactose fermenters. From the remaining sample 154 cultures were isolated. These cultures were grouped as follows:

Aerobacter section	6.3 per cent
Escherichia section	93.5 per cent

The chief numbers of the Escherichia type occurred in the following order: E. communior, 25.3 per cent; E. acidi lactici, 25.3 per cent; E. coli, 11.6 per cent; E. pseudocoscoroba, 5.2 per cent; E. neapolitanum, 2 per cent, while the remainder were atypical in one or more characteristics.

It is impossible from the above results to conclude that the Aerobacter section of the colon group is present in any great numbers in any of these waters. On the other hand Rogers (5), Stokes (6) and Wood (9) have reported conditions which are quite the reverse, and which would seem to be difficult to reconcile. As a result of their investigation of the New Haven waters, Winslow and Cohen reach the conclusion that the significance of the ratio of Bact. coli and Bact. aerogenes group in a sanitary examination of water would have little significance, in case results similar to theirs were obtained in other regions.

A matter which merits discussion in interpreting the present results is the viability of these types in water. It has been demonstrated by the experiments of Rogers (4) that Aerobacter does not die off nearly as rapidly as the Escherichia type when stored in water bottles, or in parchment bags in running streams. The work of Winslow and Cohen (7) gave similar results. There seems little doubt therefore that the Aerogenes type will persist longer in water under natural conditions than Escherichia.

How, then, are we to account for the overwhelming predominance of the Escherichia type in these deep fissure springs in which the total bacterial content is extremely low and where the water doubtless travels underground for a considerable distance and which during dry periods could not possibly be recently polluted from the surface? There seems to be but one approach to this problem. The explanation must be sought through a study of the catchment area which furnishes the water and from which it obtains its pollution. The catchment area is vast in extent and is made up prin-

cipally of the Edwards limestone of the Plateau of the Plains, and the outcrop of the Glen Rose formation and Travis Peak sands, which occur along its western borders. The rain water which falls on the Edwards Plateau percolates downward through the limestone itself to the water bearing strata. This percolation is frequently hastened and the water reaches the embed through intricate conduits from the surface such as fissures and caves and honeycombed spaces in the limestone area. These caverns facilitate both the vertical and horizontal movements of the water. Throughout this limestone region there are found numerous underground passages, some of which are quite large in extent. Such cavities have been frequently penetrated by drill holes in the vicinity of San Marcos and San Antonio. Another factor which must be taken into account in attempting to interpret the results of the bacterial content of these waters is the extent of population which occupies the section of the Plateau from which the water comes. This is a rough and rugged country with rocky soil, not suitable to extensive development of agriculture and supports only a very limited human population. It is chiefly grazing country and there are many large sheep, cattle and goat ranches. It is evident, therefore, that such pollution as finds its way into the percolating water is derived from animal sources rather than from cultivated soils or human sources. The bacteria belonging to the colon group are doubtless very abundant at the time of the initial pollution and are predominantly of the types typical of animal feces. That E. communior is the predominating type is not therefore to be considered strange. It also seems that any interpretation of the relative incidence of the type of colon bacteria in water should take into account the local conditions which affect it.

SUMMARY AND CONCLUSIONS

The water which supplies the chain of "sweet water" springs alone the line of the Balcones escarpment has its source in the vast plain of the Edwards Plateau and the outcrops of the Glen Rose formation.

The springs are fissure springs, natural artesian wells, which come from a water-bearing stratum located only a few hundred feet below the surface. The water rises due to hydrostatic pressure.

The nature of the limestone formation of the Plateau facilitates rapid movement of the water both vertically and horizontally.

The predominant type of the colon group, as determined by examination of Endo plates and the study of 154 cultures, is the Escherichia type rather than the Aerobacter type.

The nature of the catchment area is such that the surface pollution is from animal feces rather than cultivated soil or human sources.

Escherichia communior is the predominant type present in these waters. The presence of colon bacteria of the Escherichia type in these waters is not of such great sanitary significance as would be the case if the catchment area supported a more numerous human population.

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NITRATE DETERMINATIONS[1]

By Geo. W. Burke[2]

The method for the quantitative estimation of nitrate nitrogen in water and sewage as given in "Standard Methods of Water Analysis," specifies that the residue from evaporation of the sample be moistened with 2 cc. of phenoldisulphonic acid, diluted, neutralized, and finally made up to 50 cc. in a Nessler tube in readiness for comparing with standards.

It has been observed that the color imparted by adding 2 cc. of phenoldisulphonic acid to sufficient nitrate-free water and alkali to neutralize and bring the volume up to 50 cc. is sufficient to lead one to believe that considerable nitrate is present. This color is somewhat brownish in appearance and darker than the true color produced by making alkaline the small amounts of the nitrate standard solution contained in the standard Nessler tubes. Under these conditions it is quite impossible to make use of a blank determination to offset this coloration. It has been found that, if the same amount of phenoldisulphonic acid (1 cc. is sufficient), is added to each of the Nessler tubes containing the standards as was used to moisten the evaporated residue of the sample, a condition will be brought about wherein similar shades will be obtained. The sample can now be accurately matched by one of the standards.

When dealing with samples of sewage containing considerable organic matter of such a nature that it cannot be eliminated by filtration, clarification, etc., it has been found that the phenoldisulphonic acid method cannot be employed due to the darkening effect produced by the action of the strong acid upon the organic matter. Under such circumstances it is necessary to resort to the reduction method.

In the reduction method the sample, freed from ammonia, that is, introduced into the tube for reduction, contains all the nitrite and nitrate nitrogen which is reduced to ammonia. Due to the fact that

[1] Presented before the Iowa Section meeting, November 6, 1924.

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the nitrite value (otherwise determined), has to be subtracted from the nitrite plus nitrate value obtained by nesslerization, it is necessary to know accurately the value of the nitrite standard solution in terms of the ammonia standards. This is best determined by reducing a sample of the nitrite standard solution and obtaining its value in exactly the same manner as the reduction method is carried out. A blank should be employed in this connection. Having the nitrite solution standardized in this manner the proper deduction can be made to secure the correct value for the nitrate content of the sample.

As to the distillation of the reduced sample, a good practice is to boil a sufficient amount of slightly alkaline distilled water, on the condensing apparatus, until the distillate is free from ammonia. When such a condition is brought about the water is cooled, and the sample is added and distilled, the distillate being caught in a 250 cc. graduated flask. After the flask has filled with distillate it is shaken up and an aliquot is nesslerized.

USE OF CHINIC ACID IN THE DIFFERENTIATION OF THE COLON-AEROGENES GROUPS[1]

By B. H. Butcher[2]

In 1911, Beijernick called attention to the fact that some strains of Bact. aerogenes produce a red to black coloration in a medium containing chinic acid and a ferric salt, this taking place under aerobic conditions. Strains of Bact. coli, he says, do not color the medium under similar conditions. In such a medium, under anaerobic conditions a fermentation may occur with some members of the aerogenes group in which carbonic, acetic and propionic acids are formed. An attempt was made by the writer to duplicate this anaerobic type of fermentation by organisms of the colon aerogenes group, but without success. Both Smith and Durham tubes were used, but no carbon dioxide was detected. However, the coloration produced by Bact. aerogenes when it grows on chinate medium under aerobic conditions was found to be pronounced. The color produced is soluble and diffuses through the medium in both solid and liquid. It was thought that this observation of Beijernick might be used as a possible differential test for colon-aerogenes strains.

The laboratory tests usually employed for the differentiation of the coli and aerogenes sections are the Voges Proskauer and the methyl red reactions. Both of these are classified as color reactions and require a medium consisting of dextrose, peptone and phosphate. There are other tests which may be considered supplementary to the Voges Proskauer and methyl red reactions. Thus, in considering the coli sections the gas ratio CO_2/H_2 is nearly 1:1 and indol usually positive. The aerogenes section shows a gas ration CO_2/H_2 of 2:1 and indol usually negative. Another interesting differential test is that of Koser (1922). He states that Bact. aerogenes will produce abundant growth in a medium in which a sodium, potassium or ammonium salt of citric acid is the sole source of carbon. The citric acid medium will not support the growth of Bact. coli.

[1] Presented before the Iowa Section meeting, November 6, 1924.

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This work on the chinic acid medium and its coloration was begun with the belief that it might prove to be a useful test which could be used in connection with the various differential tests just mentioned. The medium used is as follows:

H_2O	1000 cc.
K_2HPO_4	0.5 gram
NH_4Cl or peptone	0.5 gram
$FeCl_3$	0.1 gram
Calcium chinate	10.0 grams

Chinic acid is in chemical terms, hexa-hydro-tetra-oxy benzoic acid. The calcium salt is made by neutralization with CaO. The minimum quantity of the calcium salt to be used is 0.5 to 1 per cent. It has been found preferable to inoculate agar agar slants or plates rather than a liquid medium, since the coloration in case of Bact. aerogenes is due to an oxidizing action. Di-hydroxy-benzoic acid is an oxidation product of chinic acid. This di-hydroxy-acid is responsible for the dark coloration with a ferric salt present. Obviously more favorable aerobic conditions are obtained on the surface of solid than in liquid cultures. After inoculation the chinate medium is incubated at 37° and within twenty-four hours some strains of Bact. aerogenes produce a distinctly dark color on the surface of slants or plates and the color soon diffuses. Other strains which do not give a distinctly positive Voges Proskauer reaction require three or four days of incubation to develop a pronounced coloration.

A total of forty-three known organisms were tested on the chinate medium. Eighteen of them were members of the aerogenes section. Of these eighteen there were six belonging to the species Bact. aerogenes, five to the species Bact. oxytocum, six were Bact. cloacae, and two were Bact. levans. The Bact. aerogenes and Bact. oxytocum organisms checked with the Voges Proskauer reaction. The Bact. cloacae, and Bact. levans tried produced no coloration in chinate medium. This observation indicates the possibility of using the test to differentiate organisms even within the aerogenes group as well as between the coli and aerogenes groups. Of the twenty-three strains of the coli section tested, none gave any coloration to the chinate medium as table 1 shows.

It was thought that, since the coloration produced in the chinate medium by organisms is a result of an oxidizing enzyme, the addition of a source of oxygen to the medium in the form of nitrate might

hasten the appearance of the dark color, but the nitrate had no appreciable effect.

A stock medium containing 1 per cent of calcium chinate may be preserved for many weeks without any coloration resulting from oxidation by the air. This is true even at 37° especially if a solid medium is being preserved.

TABLE 1

		Voges-Proskauer	Methyl red	Gelatin	Motility	Glycerol	Coloration on chinate medium
Aerogenes section	Bact. aerogenes (6 strains)	+	−	−	−	+	+
	Bact. oxytocum (5 strains)	+	−	−	−	+	+
	Bact. cloacae (6 strains)	+	−	+	+	−	−
	Bact. levans (2 strains)	+	−	+	+	−	−
Coli section	Bact. coli (6 strains)	−	+				−
	Bact. communior (1 strain)	−	+				−
	Bact. coscorba (2 strains)	−	+				−
	Bact. grunthali (6 strains)	−	+				−
	Bact. pseudo coloides (1 strain)	−	+				−
	Bact. schafferi (4 strains)	−	+				−
	Bact. neopolitanum (2 strains)	−	+				−
	Bact. Vesiculosium (1 strain)	−	+				−

In summation, it may be said that the chinic acid test agrees well with other differential tests of the colon-aerogenes group and it should prove a convenient and valuable method to be used in species identification.

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Leonard Metcalf

Born at Galveston, Tex., August 26, 1870
Died at Concord, Mass., January 29, 1926

In our JOURNAL for December, 1925, there is a characteristic contribution from Leonard Metcalf, on "Price Trends upon Centrifugal Pumps." It was written while he was dying of cancer of the stomach at his home in Concord, Mass., but nowhere in it is there any indication of his knowledge that it was probably the last thing he would ever be able to do for our Association, whose welfare had been so close to his heart for many years. At the Louisville Convention, a very few of his intimates knew that this dread disease had laid its fatal hands on him, but nothing he did or said there gave any inkling that he was aware it was probably the last meeting he would attend. That was his attitude throughout the whole of his long illness. He accepted the inevitable without comment, and worked as well as his slowly failing strength permitted to the very end, without complaint, efficiently and logically as ever.

Ever since he joined our Association in 1903 he took a deep interest and active part in its work. He contributed numerous papers, took part in many discussions and in the investigations of several important committees, and served as our President in 1916–1917. He cordially coöperated in establishing our Council on Standardization and was one of the advisers of Mr. Little, then President, in appointing the first members of that body. His interest in its work never flagged and he was the largest individual contributor of material to its "Manual of American Water Works Practice," most of these contributions being made after he knew that the remaining span of his days was brief.

In his work for our Association the characteristic of thoroughness which marked everything he did was fully shown. In fact, his last word to us, in the article in the December JOURNAL, is a rounding-out of an earlier contribution to the "Manual" and contains data that will long prove of value to those making valuations of water works.

This thoroughness not only covered technical matters but business affairs as well. His unusually wide range of interests made him for many years a trusted, valued adviser of owners of public utilities as well as of trustees of municipal plants. At one time he operated a number of water and electric plants for their owners. In business as in engineering, there are often several ways of accomplishing a given object, and the choice between them can be made safely when the details of each way are fully understood. His thoroughness rendered his advice particularly useful in solving such problems, and for years he held the reputation of a man who was familiar with the details of all procedures but had no favorites among them, using in each case that which was best suited for the conditions of it.

He began his practice as a consulting engineer in 1897 and in 1907 he joined Harrison P. Eddy in establishing the firm of Metcalf & Eddy. Early in his consulting practice he was engaged in legal cases involving valuations of water works for rate making and for sale, and until his death this class of work occupied much of his personal time. He was unusually successful in it and made a deep impression upon courts and public utility commissions before which he testified. This may be indicated by a letter sent to one of the partners in his firm by Hon. Charles E. Gurney, chairman of the Public Utilities Commission, after he learned of the fatal illness of Mr. Metcalf:

> Among the emoluments of my present position, more attractive to me than the financial return, are some of the men I have met, whose lives and achievements inspired my admiration and an endeavor to do my best work each day. None of them has impressed me more deeply for qualities of character, a manifest integrity and a steadying earnestness of purpose than Mr. Leonard Metcalf, of your firm. I always felt as he testified before this Commission that there was no danger of his stultifying himself by making any statement in which he himself did not place implicit confidence. I felt that he would not exaggerate wantonly and that I could depend upon what he told me. I do not mean by this that I closed my own mind and accepted his word as infallible, but I do mean I felt that so far as human error honestly made might be excluded, Mr. Metcalf's word might be accepted and that he would not sell his opinion to the highest bidder.

When the American Society of Civil Engineers undertook the great task of clearing away the tangle in which the engineering features of valuation work had become involved, he was appointed a member and secretary of its Committee on Valuation. Upon him fell a very laborious task, which he executed patiently, carefully

and with great tact. It is not belittling the services of the other members of this Committee to say that no small part of the credit for the successful outcome of its investigations was due to him. As commissions and courts continue to deal with this subject, it is interesting to observe the steady trend of their decisions toward those views which he advocated consistently. His reputation as an authority on the subject will continue to grow and the indebtedness we owe to him for his pioneer work in behalf of justice and equity in such matters will be better understood in the future than it is now.

In the Spring of 1917 he was appointed a member of an advisory committee to the sub-committee on Emergency Construction of Buildings and Engineering Structures of the Council of National Defense. The other members were George W. Fuller and Asa E. Phillips. It was largely through their efforts that civilian experts were obtained so promptly to carry on the construction of camps and cantonments and the apparently impossible task of having quarters ready for the first draft when it arrived was accomplished. In this work Mr. Metcalf's wide knowledge of engineers and contractors, his fearlessness and above all his judicial temperament made his services invaluable. When the work was finished he returned to his practice, but not before he volunteered his services to the Chief of Engineers for overseas duty of any kind for which his experience fitted him. The personnel division of the army realized, however, that he was more useful in his civilian life than in any of the subordinate posts in the A. E. F. which were then unfilled and this offer was not accepted.

He was an excellent business man, as was to be expected from his logical mind, tactful manner, and fearlessness. But he was also a very human individual, quick to see the humor of a situation and wholly without sensitiveness about the fact that sometimes he caused the humor of an incident. He had a personal experience he occasionally told, with much amusement at his own part in it, to persons who expressed regret that masses of men are sometimes swayed by emotion rather than logic. He was much interested in public affairs in his home town of Concord, and at a meeting there one evening he thought he noticed a trend toward a conclusion justified neither by facts nor logic. So he closed the discussion by what he considered a very clear explanation of valid reasons for making a certain decision Then a vote was taken in which he was the only supporter of his plan, the rest of the audience voting solidly for what he op-

posed. This defeat of logic caused him only amusement, for he had done his duty as he saw it and if others did not agree with him he realized they should vote as they thought. This was characteristic of his attitude during some of the old controversies in our Association. There was nothing of personal prejudice about them, so far as he was concerned, and he acted always as he thought best for the Association's welfare.

His dignified carriage and speech immediately told those who met him for the first time that he was a truly learned man. He was graduated from the Massachusetts Institute of Technology in 1892 and deeply interested in its welfare throughout the rest of his life. He served a term as president of its Alumni Association and was a member of the Corporation of the Institute at the time of his death. In early life he was for two years professor of mathematics and engineering at the Massachusetts Agricultural College and considered this experience a valuable part of his training for subsequent professional work. His scholarship went much farther than technical studies, however, and he was well informed in many branches of literature and art. He was a lover of Nature and his favorite recreation was climbing the mountains of California and Colorado. His summer home was in the Colorado Rockies, acquired recently, which he did not live to enjoy so fully as he had anticipated when he bought it.

It is difficult to dissociate his personal work from that of his associates in the firm of Metcalf & Eddy. He was not only an indefatigable worker himself, but also possessed the ability to draw out the best work of which others were capable. A good deal that he accomplished was supplemented by them, so that his firm was marked by the team work it did and it is best, therefore, to leave an outline of his engineering accomplishments to the memoir of his career which will be issued later by the American Society of Civil Engineers.

His contributions to our own Association were so many, his cheerful personality was welcomed by so many of our members, his wise counsel so highly valued, that no other tribute is appropriate here than that in his passing from our midst we have lost one of the most sagacious, respected and beloved builders of our Association, as it is today.

John M. Goodell.

ABSTRACTS OF WATER WORKS LITERATURE

Frank Hannan

Key: American Journal of Public Health, **12:** 1, 16, January, 1922. The figure 12 refers to the volume, 1 to the number of the issue, and 16 to the page of the Journal.

Distillery Waste Liquids and Their Purification. R. D. Littlefield. Chem. and Ind., **44:** 680. Seven page article describes in some detail character of waste liquors from distilleries and experimental plant for treating them. Wastes have exceedingly high oxygen demand, requiring in some cases 50,000 parts per million of dissolved oxygen for complete oxidation. For treatment, liquors were diluted with 10 volumes of water, precipitated with lime, and settled. Settled liquor was treated on trickling filter at rate of 20 gallons per cubic yard per 24 hours. Effluent from this process had five day biological oxygen demand of 4.3 parts per million, and was shown to be satisfactory for fish life by experiments in small hatchery.—*A. M. Buswell.*

Iodine and Water Supplies. H. W. Clark. Eng. News Rec., **95:** 470, 1925. Average I content of 80 Massachusetts water supplies examined was 2.14 parts per billion, individual supplies having content as high as 6.3 parts per billion. These results are being studied in relation to prevalence of goiter. Use of iodized salt is considered ideal method of overcoming I deficiency, application of I to water being considered more or less wasteful.—*R. E. Thompson.* (*Courtesy Chem. Abst.*)

System of sanitary grading of water supplies. E. Sherman Chase. Eng. News-Rec., **95:** 469–70, 1925. Consists of scale of values from 0 to 100 divided into 3 parts of 50, 20, and 30, which are assigned to factors for pollution hazards, protective measures, and quality condition, respectively. Maximum value indicates perfect or nearly perfect conditions.—*R. E. Thompson.* (*Courtesy Chem. Abst.*)

Phenol Tastes in the Water Supply of Marquette, Mich. Paul Hansen. Eng. News Rec., **95:** 469, 1925. Presence of pyroligneous acid and crude wood alcohol still wastes in the water supply of Marquette, derived from Marquette Bay, Lake Superior, has given rise to tastes and odors which are intensified by chlorination. On basis of Milwaukee experiments it is proposed that troublesome wastes be partially treated at works of origin and then discharged with city sewage into reaction tank (designed for possible conversion into activated sludge plant) with retention period of approximately 8 hours. Ratio of waste to sewage is approximately 1:15.—*R. E. Thompson.* (*Courtesy Chem. Abst.*)

Close Water Control Important in Alumina Cement Concrete. P. H. Bates. Eng. News Rec., **95**: 462–3, 1925. Experiments showed that marked decrease in strength accompanies use of excess water with high alumina cement, as little as 0.5 per cent (of weight of dry mix) causing distinct reduction. Grading of aggregate, by influencing amount of water required to secure workability, is also a factor.—*R. E. Thompson.* (*Courtesy Chem. Abst.*)

Method for Testing Fine Aggregate. G. W. Hutchinson. Eng. News Rec., **95**: 395, 1925. As standard test methods are of questionable economic value, attempt was made to devise method more consistent with use of fine aggregate under field conditions. Test adopted consists in proportioning materials as follows—dry volume: cement 23 per cent, fine aggregate 46 per cent, coarse aggregate 76 per cent employing a standard consistency analagous to that required in field concrete. Specimens, 3 x 6 inches cylinders, were stored in moist closet until compared with similar specimens made with standard Ottawa sand. Prepared coarse aggregate (Mascot Chats), grade $\frac{3}{8}$ to $\frac{3}{4}$ inch, was employed.—*R. E. Thompson.* (*Courtesy Chem. Abst.*)

Chlorinator has Daily Capacity of 750 Pounds. Eng. News Rec., **95**: 365, 1925. Injector type chlorinator, with capacity of 750 pounds per 24 hours, developed by Paradon Engineering Company for New York City water department for use with 1-ton containers used by that department, is described briefly and illustrated. Apparatus has range of capacity of $7\frac{1}{2}$ to 1 and is equipped with automatic chlorine shut-off device operated by water pressure.—*R. E. Thompson.* (*Courtesy Chem. Abst.*).

Use of Iodides in Water Supplies to Prevent Simple Goiter. Arthur F. Mellen. Eng. News Rec., **95**: 352–4, 1925. Adverse criticisms of iodization are reviewed and commented on. Minneapolis supply, filtered Mississippi River water, contains only approximately 0.8 part per billion of I, compared with minimum content of 5 parts found in waters in non-goitrous regions. Author's proposal deficiency be corrected by addition of 10 parts per billion of NaI has been favorably considered. Cost is estimated at $1\frac{1}{2}$ cents per capita per annum.—*R. E. Thompson,* (*Courtesy chem. Abst.*)

Brookline, Mass. Eng. News Rec., **95**: 259–60, 1925. Water supply (5 m.g.d.) is obtained from driven wells and underground collecting galleries located on banks of Charles River. Purification works consist of 6 tricklers, a sedimentation basin, and 6 slow sand filters.—*R. E. Thompson.* (*Courtesy Chem. Abst.*)

Frozen Concrete Due to Undesirable Material. Walter H. Wheeler. Eng. News Rec., **95**: 232, 1925. Brief discussion of failure of Gem Lake Dam in which opinion is expressed that dense concrete, equal to 1:2:4 mix in richness, made with clean aggregates which have water absorption of less than 1 pound per cubic foot, will not be disintegrated by freezing and thawing.—*R. E. Thompson.* (*Courtesy Chem. Abst.*)

Suggests One-day Strength Test for Concrete Aggregate. Searcy B. Slack and J. E. Boyd. Eng. News Rec., **94:** 1014–5, 1925. Results of experiments employing alumina cement and 1-day test period for strength and compression tests of concrete aggregates are given which indicate that the 24-hour test is feasible and gives results comparable with present 28-day test with Portland cement.—*R. E. Thompson.* (*Courtesy Chem. Abst.*)

Accelerated Sand Tests with Alumina Cement. N. W. Dougherty. Eng. News Rec., **95:** 113, 1925. Parallel tests of sand for concrete using 7- and 28-day portland cement and 24-hour alumina cement methods gave comparable results except for compressive strength of limestone screening, which was low by latter method. Previous experiments have shown that limestone screening with portland cement gives unusually high tensile and compressive strength. (Cf. previous abstract.)—*R. E. Thompson.* (*Courtesy Chem Abst.*)

Pumping Station Improvements at York, Pa. F. G. Cunningham. Eng. News Rec., **95:** 135, 1925. Water supply is pumped from Cadorous Creek against static lift of 290 feet to large reservoirs on a hill, filtered, and distributed by gravity. New boiler, and additional pump and filter units have recently been contracted for.—*R. E. Thompson.* (*Courtesy Chem. Abst.*)

Annapolis, Md. Eng. News Rec., **95:** 95, 1925. Water is drawn from impounding reservoir on Broad Creek and passed through sedimentation basin to reservoir from which it is delivered by gravity to mains. Purification by filtration is under consideration.—*R. E. Thompson.* (*Courtesy Chem. Abst.*)

Variable Cement Tests. Wm. Mueser. Eng. News Rec., **95:** 154, 1925. Instance of discrepancies in results of examination of concrete materials carried out in different laboratories is cited and commented on It is suggested that there is widespread doubt as to reliability of cement testing.—*R. E. Thompson.* (*Courtesy Chem. Abst.*)

City of Washington Builds Nine-Mile Aqueduct. Eng. News Rec., **95:** 88–93, 1925. Illustrated description of what is virtually a second water supply system for Washington, D. C., comprising aqueduct, rapid sand gravity filter plant of 80 million gallons per day capacity (20 units), 2 high pressure reservoirs, and a hydro-electric plant for generating power for pumping. Estimated expenditure involved is $9,000,000. Plant for alum manufacture has been included.—*R. E. Thompson.* (*Courtesy Chem. Abst.*)

Well-managed Private Water Plant at Lexington, Ky. Eng. News Rec., **95:** 62–3, 1925. Works of Lexington Water Company consist of 2 series of impounding reservoirs, rapid sand filter plant, and necessary pumping equipment. Services are 100 per cent metered and average daily per capita consumption is 85 gallons. Meters are read at rate of 70 per man-hour. Coal consumption in boiler plant has been reduced from 32,000 to 20,000 pounds per 24 hours in last 3 years, notwithstanding 5 per cent increase in water use (4 to 4.2 million gallons per day).—*R. E. Thompson.* (*Courtesy Chem. Abst.*)

Greensboro, N. C. Eng. News Rec., **95**: 61, 1925. Water is pumped from billion-gallon impounding reservoir on Reedy Fork Creek to 20 million-gallon reservoir from which it flows 6 miles by gravity through two 24-inch mains (one cast iron, the other wood) to filtration plant which was constructed 2 years ago.—*R. E. Thompson.* (*Courtesy Chem. Abst.*)

Wilmington, N. C. Eng. News Rec., **94**: 1018, 1925. Purification of the water supply, which is drawn from Cape Fear River, has presented difficulties owing to variable color and turbidity. Notwithstanding purity of water as at present delivered, city is still compelled to maintain 37 deep wells to which people come for drinking water. Average quality of city water is as follows:—alkalinity 14.4; chlorides 5; turbidity 0; odor, none; total bacterial count at 38°, 2; B. coli absent in 50 cc.—*R. E. Thompson.* (*Courtesy Chem. Abst.*)

Ventilation Methods in Florence Lake Tunnel. Eng. News Rec., **94**: 1010–12, June 18, 1925. Ventilation methods employed during construction of Florence Lake tunnel of Southern California Edison Co., described. Factors found to be important were: use of auxiliary blowers as boosters when lines exceeded 10,000 feet in length, use of curtain of small jets of compressed air to retain powder gases near heading until foul air could be exhausted, and improvement in size of cartridge and materials used in blasting. Three types of ventilating pipe, wood-stave, corrugated iron lined with sheet metal, and plain 12-gage steel, were employed; all 24 inches in diameter. Latter was found most satisfactory, as drying of staves of wood pipe resulted in leakage, and friction losses in corrugated pipe were excessive.—*R. E. Thompson.*

Centrifugal Pumps at Waterville Meet Unusual Requirements. ARTHUR L. SHAW. Eng. News Rec., **94**: 1020, June 18, 1925. Due to varying friction losses in 8.4 miles of supply aqueduct at different pumping rates, head on suction side of pumps ranges from 90 feet static pressure to 12 feet suction lift, and difficulty has been experienced in obtaining reasonable pumping efficiency. Problem finally solved by pumping units consisting of series-connected single-stage pumps which can be operated singly when desired. Characteristics of units shown graphically.—*R. E. Thompson.*

Automatic Spillway Gates of Black Canyon Dam. JULIAN HINDS. Eng. News Rec., **94**: 1046–50, June 25, 1925. Conditions under which diversion dam across Payette River will be operated are such that flood water must be passed with practically no increase in water level, and to meet these requirements crest gates of drum type, operated by variation in water level, have been in-installed. The gates, automatic control device, and special rubber seal employed are described in some detail and illustrated.—*R. E. Thompson.*

Present Status of San Francisco's Hetch Hetchy Project. Eng. News Rec., **94**: 1021–3, June 18, 1925. Work completed, under construction, and proposed, outlined. To date approximately $44,000,000 has been expended on project; a $10,000,000 bond issue was approved last October, and further issue of $23,000,000 will be required to complete work. Present consumption in San

Francisco is approximately 42 m.g.d. and maximum amount which can be brought in economically from all sources prior to Hetch Hetchy delivery is 60 m.g.d., which will meet requirements for no longer than next 6 years. Estimated that project can be completed in that time.—*R. E. Thompson.*

Design Considerations of Dix River Rock-Fill Dam. Eng. News Rec., **94:** 1058–61, June 25, 1925. Upstream face of dam was built to slope of 1 on 1.2 at bottom changing to 1 on 1 at top, and is protected by tightly laid dry rubble slope-wall placed directly on rock fill, 14 feet in thickness at base and 7 feet at normal water level, and by concrete pavement ranging in thickness from 18 inches at bottom to 8 inches at top. The concrete forms for lower 160 feet, constructed of well-seasoned, tongued and grooved, 3 x 10 yellow pine lumber, bolted into the concrete, will be left in place permanently as additional safeguard against seepage. It is believed that sheeting will swell to form very tight diaphragm, as permanent under water as concrete itself, or possibly more so.—*R. E. Thompson.*

Corroborates Some Doubts Raised by Milwaukee Experiments. J. W. Ellms. Eng. News Rec., **94:** 1062, June 25, 1925. E. believes that use of wood-grating filter underdrains, such as those at Sacramento (cf. this Journal, **14:** 4, 364) would result in uneven washing unless velocity in main channel and separate waterways was very low. Use of cemented-gravel layer is not favored, as velocity head can be controlled more easily in strainer system than in gravel layer. Gravel depth of 18–21 inches considered most satisfactory. (See following abstracts.)—*R. E. Thompson.*

Metal Distribution More Dependable Than Gravel. Wellington Donaldson. Eng. News. Rec., **94:** 1062–3, June 25, 1925. D. considers "metal" distribution of wash water to be more dependable than "gravel" distribution, owing to low resistance of latter. An objection to cemented-gravel layer is possibility of clogging and inability to overhaul without complete destruction and replacement. Air entrainment should be combated at source rather than by modification of underdrains. (See previous and following abstracts.)—*R. E. Thompson.*

Baltimore Experience with Slat Bottom Type Satisfactory. Jas. W. Armstrong. Eng. News Rec., **94:** 1063–4, June 25, 1925. Sacramento results can be explained by thin layer of gravel employed. With proper depth and grading of gravel, cemented-gravel layer, as suggested, would be unnecessary. One filter of slat bottom type has been successfully operated in Baltimore for 4 years and additional units are under construction. (See previous and following abstracts.)—*R. E. Thompson.*

Iron Ridge Block Diffusers and Wood Grating Used at St. Paul. John W. Kelsey. Eng. News Rec., **94:** 1064, June 25, 1925. Filters equipped with iron ridge block diffusers and wood grating have proved satisfactory at St. Paul, giving uniform wash at rate of 2 feet vertical rise per minute. (See previous and following abstracts.)—*R. E. Thompson.*

Cemented-Gravel Slabs Satisfactory at Toronto and Elsewhere. WM. GORE. Eng. News Rec., **94**: 1064–5, June 25, 1925. Cemented-gravel layer, resting upon loose gravel covering perforated pipe underdrains and covered with 2 inches of coarse sand, has been successfully employed in drifting sand filters to prevent interference of gravel with operation of sand extractors. Recent examination at Toronto showed that cement was being slowly dissolved by water and that layer, although sound, was more porous than when placed 6 years before. Proportion of cement has been increased from 1:15 to 1:12. (See previous abstracts.).—*R. E. Thompson.*

Flow Losses in Large Pipes (and Open Channels). HARRISON P. EDDY. Eng. News Rec., **94**: 1070, June 25, 1925. Excess loss, of head in curves and bends is probably due largely, if not wholly, to disturbance of flow conditions by which thread of maximum velocity is deflected nearer outside of curve and velocity filaments in contact with wetted perimeter in this portion correspondingly increased as compared with those obtaining when flow is in straight lines. This probably results in considerable increase of average velocity of filaments in contact with surface of conduit and consequently in increased frictional loss, while mean velocity remains unchanged. (Discussion of article of F. C. SCOBEY, cf. this JOURNAL, **14**: 6, 602).—*R. E. Thompson.*

Drains Under Earth Dams. ALLEN T. BLYTHE. Eng. News Rec., **94**: 1070, June 25, 1925. Discussion of failure of French Landing Dam (cf. this JOURNAL, **14**: 5, 480) and of advisability of employing drains.—*R. E. Thompson.*

Drains Under Earth Dams. GARDNER S. WILLIAMS. Eng. News Rec., **94**: 1070–1, June 25, 1925. Reply to above, quoting successful applications.—*R. E. Thompson.*

Probability Methods for Rainfall and Run-off. CHAS. W. SHERMAN. Eng. News Rec., **94**: 1071, June 25, 1925. Discussion of article of S. L. MOYER (cf. this JOURNAL, **14**: 6, 603) with reference to advisability of using yearly maximum as essential data, and omitting all secondary maxima even though materially higher than some of yearly maxima. (See following abstract.)—*R. E. Thompson.*

Probability Methods for Rainfall and Run-off. S. L. MOYER. Eng. News Rec., **95**: 74, July 9, 1925. Reply to above.—*R. E. Thompson.*

Coefferdam Built to Dislodge Cleaning Ball in Lake Outlet Sewer. CHAS. A. FRENCH. Eng. News Rec., **95**: 10–1, July 2, 1925. Cleaning ball which had become lodged 50 feet from shore in lake outlet at Laconia, N. H., was removed by constructing cofferdam and cutting opening in pipe with electric drill. Opening was repaired by clamping plate to pipe, calking with sheet lead, and embedding in concrete.—*R. E. Thompson.*

Multiple Arch Dam Disintegrated Under Low Temperatures. Eng. News Rec., **95**: 22–3, July 2, 1925. Disintegration of concrete of multiple arch dam

on Gem Lake, California, attributed to frost, described and illustrated. Structure was repaired by pouring concrete gravity section behind arches.—*R. E. Thompson.*

Subaqueous Pile Driving at Portland, Ore. Eng. News Rec., **95**: 53-4, July 9, 1925. Pile driving to depth of 65 feet below water surface by means of subaqueous hammer described and illustrated.—*R. E. Thompson.*

Partial Failure of Earth Dam at Horton, Kans. E. B. Black. Eng. News Rec., **95**: 58-9, July 9, 1925. Illustrated description of partial failure of dam forming Mission Lake, from which Horton, Kans., derives its water supply. Data on record-breaking rainfall and flood which overtopped dam, and brief details of temporary and permanent repairs carried out, included.—*R. E. Thompson.*

Testing an Arch Dam. Fred A. Noetzle. Eng. News Rec., **95**: 74, July 9, 1925. Brief reference to experimental program in connection with proposed test dam of Engineering Foundation (cf. this Journal, **14**: 5, 480).—*R. E. Thompson.*

Hydraulic Turbine of New Design Developed in England. F. Johnstone-Taylor. Eng. News Rec., **95**: 72-3, July 9, 1925. Banki turbine, for development of small quantities of power at low-head, described and illustrated. Wheel will operate with loss of efficiency of not more than 10 per cent when completely submerged.—*R. E. Thompson.*

New Graphic Water Level Recorder Has Range of Use. Eng. News Rec., **95**: 80, July 9, 1925. Brief description of instrument manufactured by W. and L. E. Gurley, Troy, N. Y.—*R. E. Thompson.*

New Formula for Flow of Water in Clean Cast Iron Pipe. Edward Wegmann and Albert N. Aeryns. Eng. News Rec., **95**: 100-2, July 16, 1925. Formula given which agrees more closely with experiments than any other. Average per cent variation in velocity from that by new formula is as follows: experiments (260 records were found, some of which showed marked variations), −0.5; Hazen and Williams, +5.6; Williams, +1.1; Ganguillet and Kutter, +1.1; Barnes, −5.6; Lampe, +4.2; Flamant, +5.9.—*R. E. Thompson.*

Sanitary Protection of Water Supplies Taken from National Forest Areas. Eng. News Rec., **95**: 113-4, July 16, 1925. Discussion of sanitation of National Forest Areas by J. B. Marcellus, Lee H. Williamson, Richard Messer, and L. F. Knopp, with particular reference to Reserve in which watershed from which Staunton, Va., derives its supply is situated. Details of co-operative watershed agreement between Staunton and Dept. of Agriculture given by latter writer.—*R. E. Thompson.*

Aurora, Ill. Eng. News Rec., **95**: 133, July 23, 1925. Water supply, obtained from wells in Potsdam sandstone, although hard, is cool and free from contamination and is considered excellent supply.—*R. E. Thompson.*

Lining Pit No. 3 Tunnel Using Pneumatic Concrete Guns. Eng. News Rec., **95**: 128–32, July 23, 1925. Illustrated description of process of lining tunnel 4 miles in length and 19 feet in diameter.—*R. E. Thompson.*

Yellow Paint Used for Fire Hydrants. Eng. News Rec., **95**: 135, July 23, 1925. Yellow metallic paint has been substituted for red on hydrants in New London, Conn., and found very effective, being more resistant than red to salty and frequently foggy air of that section of country.—*R. E. Thompson.*

What Happened to Municipal Utilities at Santa Barbara. Eng. News Rec., **95**: 146–9, July 23, 1925. Damage to water supply system during earthquake of June 29 included breaks in mains and failure of centre section of dam in Sheffield reservoir in city. Condition of latter suggests that structure was previously weakened by seepage under cutoff wall. Gibraltar Dam, storing city's water supply on Santa Ynez River, was undamaged. Increased flow observed since quake is attributed to release of imprisoned pockets of water. Sewer outfall, including submerged section, was disaligned and some joints broken, and it is believed that considerable portions will require relaying.—*R. E. Thompson.*

Grand River Crossing—Spavinaw Water Supply Conduit. W. R. Holway. Eng. News Rec., **95**: 168–71, July 30, 1925. Chief construction difficulties involved in laying of 54-inch and 60-inch concrete pipe for 55-mile gravity conduit of Spavinaw Water Project of Tulsa, Okla., were due to fact that line had to be located across lines of natural drainage, necessitating crossing of 17 large streams. Excavation of pipe trench in river beds was accomplished with cofferdams constructed alternately of cribs and gates. Crossing of Grand River, which was largest and most difficult undertaking, described and illustrated. River at point of crossing is 800 feet wide and this section of 60-inch pipeline took from April to October to complete and cost approximately $125,000.—*R. E. Thompson.*

Flood Protection Studies for Syracuse. Eng. News Rec., **95**: 153, July 23, 1925. Flood possibilities and feasible methods of protection from floods at Syracuse, N. Y., are to be studied by Syracuse Intercepting Sewer Board. Flood of 3500 second-feet on Onondago Creek at Syracuse in 1901 was greatest recorded to that date, but it was exceeded in 1914 (3600 second-feet), 1915 (5500), 1920 (6000), and 1925 (5500). Possibilities of channel enlargement within city are restricted and detention works upstream may have to be considered.—*R. E. Thompson.*

Features of Newark, Ohio, Water Softening Plant. Clarence T. Kaiser. Eng. News Rec., **95**: 174–5, July 30, 1925. Newark water treatment plant consists of 2 settling basins, 4 mechanical filters, clear water reservoir, 2 dry-feed machines for alum, 2 feeders for milk of lime, and chlorinator. Features of softening plant are replaceable concrete slabs at water line on baffle boards of settling basins to facilitate repair of damage of concrete due to frost, and Dorr clarifier for continuous removal of sludge. Split treatment is employed

as water is high in magnesium. Water is finally carbonated with gas derived from breeching of boilers, which is scrubbed and dried and applied through diffusers consisting of perforated pipe surrounded by cemented sand (1:12 mixture).—*R. E. Thompson.*

Quantity Production of Ground Water from Wells in Sand. J. G. Gordon. Eng., News Rec., **95**: 188–9, July 30, 1925. Velocity of ground water increases rapidly as it approaches well, and use of gravel wall, by increasing distance between sand and well, reduces velocity of water leaving sand and, therefore, amount of sand carried into well. Gravel wall also reduces friction loss, thus increasing specific capacity.—*R. E. Thompson.*

Measuring the Physical Effect of Corrosion. E. Blough. Eng. News Rec., **95**: 185, July 30, 1925. Common criticism applicable to all current methods of determining extent of corrosion is that effect of corrosion on residual metal which is apparently unattacked is not disclosed. Suggested that specimens after corrosion should be subjected to physical tests. Application demonstrated.—*R. E. Thompson.*

Rigidity of Penstock Wye Secured by Simple Design. Eng. News Rec., **95**: 189, July 30, 1925. Near upper end of penstock supplying water to Moccasin Creek power house on Hetch Hetchy Project, two 98-inch riveted steel pipe lines branch, by means of two Y's into four lines, each 66 inches in diameter. Design of this section briefly described and illustrated.—*R. E. Thompson.*

Sheffield and Gem Lake Dam Failures. M. M. O'Shaughnessy. Eng. News Rec., **95**: 194; July 30, 1925. Failure of Sheffield and Gem Lake (see above) dams discussed. Suggested that former was due to defective materials used in construction rather than to frost. Installation of drains on downstream portion of earth-fill dams favored.—*R. E. Thompson.*

From Filters to Small Wells Then to Large Wells. W. A. Cone. Eng. News Rec., **95**: 216–7, August 6, 1925. Filtered Alabama River water supply was abandoned some years ago by Montgomery, Ala., in favor of small wells and air-lift pumping equipment. Decreasing production of system and greatly increased power rates resulted in recent installation of 5 Layne and Bowler wells equipped with vertical centrifugal pumps which has reduced cost of pumping from wells to reservoirs from 2.58 cents to 0.9 per 1000 gallons. Estimated that saving will equal cost of new equipment in 3 years. Efficiency of air-lift system (electrical input to water output) was only 10.6 per cent.—*R. E. Thompson.*

Automatic Valve Control Device Eliminates Water Hammer. Eng. News Rec., **95**: 200, July 30, 1925. Brief description of device, manufactured by Chicago Valve and Hydrant Company, that will automatically open gate, butterfly, and check valves when required pressure has been built up, or close same when power is shut off. Additional use is for automatically opening and closing valves at any predetermined rate of flow where break in mains would ordinarily drain supply.—*R. E. Thompson.*

Indianapolis Flood Protection is Progressing. Eng. News Rec., 95: 213, August 6, 1925. Flood protection work on White River in Indianapolis, two sections of which were completed in 1915–1918 as direct result of flood of March-April, 1913, is being continued. Improvement includes widening and rectification of river and lower part of its tributary, Fall Creek, and construction of levees along bank of new channel. Brief details of work under construction and proposed given.—*R. E. Thompson.*

Open Sea Construction of a Concrete Pipe Sewer Outfall. H. A. Norman. Eng. News Rec., 95: 292–4, August 20, 1925. Construction of ocean outfall from Hyperion treatment plants, Los Angeles, described and illustrated. Main trunk outfall is 5443 feet long and 7 feet in diameter, and depth of water at outshore end is 60 feet. Surf, ground swell, and heavy north and south coastwise currents were normal water conditions, much aggravated by storms. These hazards were met without serious mishap by method of submerged towing—lengths of pipe being hung from bottom of special pontoon which was towed to desired position and submerged, being again floated after placing of pipe section. Cofferdam was employed for first 800 feet—through surf. Contract price was $496,000.—*R. E. Thompson.*

Belt Conveyors Build Wanaque Dam Embankment Core Wall. Eng. News Rec., 95: 252–8, August 13, 1925. Project consists of main earth dam with concrete core wall on Wanaque River, five subsidiary dams—two of concrete and three of earth with core walls—aqueduct, and tunnel, object being to supplement present Pequannock River supply of Newark, N. J., and to serve Paterson and other neighboring municipalities which may contract for water. Reservoir will be 6 miles long and one mile wide and is situated 25 miles north of Newark. Capacity will be approximately 28,000,000,000 gallons, giving supply of 100 m.g.d. Main dam contains 830,000 cubic yards of embankment, and other three earth fills aggregate approximately 120,000 cubic yards. Concrete amounts to 77,000 cubic yards—30,000 in main dam. Excavation in rock is equivalent to 40,000 cubic yards, and earth excavation over 113,000. Probably greatest footage of belt conveyers (nearly 2½ miles) ever operated on construction job, have been installed. Excavation, fill, and haulage are also all-mechanical operations. Animals are not allowed to work within reservoir site. Construction of dams described and illustrated in some detail.—*R. E. Thompson.*

Setting Up Depreciation Reserves. Wm. E. Oberle. Eng. News Rec., 95: 278–9, August 13, 1925. Discussion of methods of creating depreciation reserves. Suggestion is made that subject be thoroughly analyzed in order that future methods may be based on sound practice.—*R. E. Thompson.*

Water Tank Collapses Injuring Two. Eng. News Rec., 95: 319 and 321, August 20, 1925. Collapse, in New York City, of 20,000-gallon wood-stave water tank supported on steel tower, described briefly. Tower was 60 feet in height and was erected 25 years ago. Corrosion stated to be contributing factor.—*R. E. Thompson.*

New London, Conn. Eng. News Rec., **95:** 305-6, August 20, 1925. Water supply is derived from Lake Konomoe, a 600-m.g., storage supply 6 miles from city, with auxiliary reservoirs of 212 and 160 m.g., 9 and 11 miles from city. Chlorination is only treatment employed. Distribution is by gravity, pressure being equalized by pumping to small reservoir within city.—*R. E. Thompson.*

Why Not Two Water Mains in Wide Streets? Thomas F. Wolfe. Eng. News Rec., **95:** 332-5, August 27, 1925. Two-main system, one main large enough for domestic consumption on one side of street and fire protection on both sides, and other smaller and having no fire hydrant connections, advocated. Advantages are elimination of difficulties regarding services to vacant lots on streets about to be paved, and reduction in cost of locating and repairing leaks. With streets 80 feet wide from lot front to lot front, blocks 660 feet long, pavement 33 feet wide, lots 25 feet wide and 1-inch lead service pipes, cost of main and service installations under each plan (8-inch pipe alone, or 4-inch and 8-inch on either side) are practically identical. Comments of 27 water works engineers and superintendents included. Additional remarks by 5 writers in Eng. News Rec., **95:** 522-3, September 24, 1925.—*R. E. Thompson.*

New Tower for Water Tank Houses Pumps at Rochester, Minn. Eng. News Rec., **95:** 338-9, August 27, 1925. Brief illustrated description of covered, reinforced-concrete, 200,000-gallon water tank constructed in 1924 to supplement 240,000-gallon wrought iron standpipe installed as part of original works in 1887. Other improvements include tubular wells and additional pumping units, part of latter being housed in tower supporting tank.—*R. E. Thompson.*

New Gravity Water Supply for Whitehall, N. Y. Jas. P. Wells. Eng. News Rec., **95:** 344-5, August 27, 1925. New 3 m.g.d. supply of soft and bacteriologically satisfactory water from Pike Brook and Pine Lake, replacing supply from Metawee River which was moderately hard and at times unsatisfactory in quality, described briefly. Features of system are considerable length of pipe laid almost unprotected on rock with an exposure to very low temperatures, and submerged section laid on soft bottom of arm of Lake Champlain. Exposed section has already had severe test, having been subjected to temperature of −45° at low velocity without appreciable decrease in discharge.—*R. E. Thompson.*

Electrically-Operated Gages Devised For Filters. Harry N. Jenks. Eng. News Rec., **95:** 346-8, August 27, 1925. Loss-of-head gages and valve-opening indicators consisting of voltmeters actuated by current varied through reactance coils, developed at Sacremento filtration plant, described and illustrated. Deflection in former is sufficient to enable readings of 0.1 foot. Cost believed to be much less than for any other type—$45 for loss-of-head gage and $10 for valve-opening indicator. Principle involved may be applied to great variety of uses—indications may be had of pressure, difference in pressure, and physical motion at any desired remote point. Invention is not covered by patents and free use is permitted.—*R. E. Thompson.*

Effect of Rio Grande Storage on River Erosion and Deposition. L. M. Lawson. Eng. News Rec., **95**: 372–4, September 3, 1925. Control of flow of Rio Grande by Elephant Butte dam, forming reservoir of 2,600,000 acre-feet capacity, has prevented large destructive floods and greatly reduced total sediment in lower river. Average annual flow at San Marcial since 1897 has been 1,225,727 acre-feet (1550 second-feet continuous flow) with maximum measured flood discharge of 33,000 second-feet. Silt content is approximately 20,000 acre-feet per annum.—*R. E. Thompson.*

Channel Improvement of Rio Grande Below El Paso. Salvador Arroyo. Eng.News Rec., **95**: 374–6, Sept. 3, 1925. Control works on Rio Grande have resulted in deposition of sand in channel below El Paso, making it inadequate, causing river to become menace to cities and irrigation development along both banks. Brief details of plan of river rectification which has been submitted to American and Mexican Governments by author and L. M. Lawson given.—*R. E. Thompson.*

Irrigation Tunnel Constructed in Earth and Hard Clay. J. K. Rohrer. Eng. News Rec., **95**: 393–4. Construction of 6500-foot irrigation tunnel near Mitchell, Neb., for U. S. Bureau of Reclamation described briefly. Tunnel is of horseshoe section, 10 feet 3 inches high, with 10-inch concrete lining. Approximately 1390 feet at north end and 1100 feet at south end are in earth, and remainder in hard clay. Timbering was required throughout.—*R. E. Thompson.*

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Use of Burned Clay, Concrete and Wood Pipe for Irrigation. R. K. Tiffany. Eng. News Rec., **95**: 419, September 10, 1925. Brief illustrated description of construction of irrigation system of Spokane Valley Irrigation District, feature of which was use of bell-less vitrified clay pipe which was very satisfactory. This type of pipe can be manufactured for 15 per cent less and laid for 10–20 per cent less than bell-and-spigot type.—*R. E. Thompson.*

Wisconsin Supreme Court Enjoins Stream Pollution. Wm. R. Copeland. Eng. News Rec., **95**: 390–1, September 3, 1925. Review and discussion of award of $50,000 damages to riparian owner by Supreme Court of Wisconsin for flooding of farm land and creation of public nuisance in waters of Honey Creek by raw and partially treated sewage discharged into stream by city of West Allis. The city was ordered to abate the nuisance within 60 days. The sewage treatment plant, consisting of contact beds and Imhoff tanks, removes 55–60 per cent of organic impurities.—*R. E. Thompson.*

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Publicizing Plans for Municipal Works. S. Harold Evans. Eng. News Rec., **95**: 426–7, September 10, 1925. Graphical representation of conditions in connection with $500,000 water project of Eugene, Ore., played important part in allaying adverse criticism and in gaining strong support for the undertaking, which consists of substituting potable supply from 7 miles up McKenzie River for present supply from Willamette River, which is dangerously polluted.—*R. E. Thompson.*

Effect of Berms on Flow in Alamo Canal. G. G. Sypes. Eng. News Rec., **95**: 433, September 10, 1925. Discussion of measurement and control of flow in Alamo Canal. Breakdown in flow relation at critical stage is attributed to berms formed around roots of trees and brush on banks.—*R. E. Thompson.*

A Plan for a Metropolitan Water District in New Jersey. Eng. News Rec., **95**: 436, September 10, 1925. Financial and administrative plan drawn up by Clemens Herschel and submitted to commission created by New Jersey Legislature to formulate comprehensive water supply policy for state is outlined briefly.—*R. E. Thompson.*

More Data on Tulsa Pipe Line Venturi Meter. Fred C. Scobey. Eng News Rec., **95**: 442, September 10, 1925. Additional data, particularly as regards loss-of-head (cf. this Journal, **14**: 6, 602).—*R. E. Thompson.*

Water Meter Ordinance for City of Chicago. Eng. News Rec., **95**: 443, September 10, 1925. Ordinance has been passed providing for universal metering of water service in Chicago in 10 annual installments. In addition, present meter rate of 62½ cents per 1000 cubic feet, subject to 25 per cent discount has been changed to 60 cents, subject to 15 per cent discount, making net increase from 46.9 to 51 cents. This is not sufficient to enable carrying out of filtration program, which would require 40 per cent increase.—*R. E. Thompson.*

Driving Wanaque Tunnel for North Jersey Water Supply. Eng. News Rec., **95**: 460–1, September 17, 1925. Illustrated description of construction of 860-foot tunnel to carry supply line under overflow channel of dam.—*R. E. Thompson.*

Water Main Breaks at Congested Corner of Fifth Avenue, New York City. Eng. News Rec., **95**: 463, September 17, 1925. Break in 20-inch cast iron bell-and-spigot pipe and repair of same described briefly. Such breaks seem to occur as result of traffic load which pipes are required to carry in excess of that for which supports were designed.—*R. E. Thompson.*

Additional Drainage Works in Little River District. E. S. Blaine. Eng. News Rec., 95: 496–500, September 24, 1925. Extensive additional works being carried out to provide adequate drainage and flood control under conditions which have developed since original works were constructed some 10 years ago included multiple main ditches, retarding basins, and high-level flow-line ditches, latter being employed in preference to floodways for high-water flow. Works described in some detail and illustrated, and relative merits of high flow line ditches and floodways compared.—*R. E. Thompson.*

Test Program For Arch Dam Investigation. Eng. News Rec., 95: 510, September 24, 1925. Brief data on test program.—*R. E. Thompson.*

Santa Monica, Calif. Eng. News Rec., 95: 511–3, September 24, 1924. Three new wells have been drilled and new pumping equipment installed. Supply is of excellent chemical quality, although slightly hard. Average consumption is 4 m.g.d. One million dollars has recently been expended on extensions to distribution system, which is wholly constructed of cast iron.—*R. E. Thompson.*

Measuring Sewage Flow By Pitometer. Arthur L. Shaw. Eng. News Rec., 95: 518, September 24, 1925. Device described by means of which pitometer orifices may be flushed to remove adhering solids.—*R. E. Thompson.* (*Courtesy Chem. Abst.*)

How to Plan District Water Supplies. Arthur H. Pratt. Eng. News Rec., 95: 560, October 1, 1924. Discussion of water supply situation in New Jersey with particular reference to North Jersey District Water Supply Commission, being reply to recent editorial on this subject.—*R. E. Thompson.*

Roofed Reservoir and Pipe Tunnel for Small Water System. Eng. News Rec., 95: 540–2, October 1, 1925. Calumet City (formerly West Hammond) recently contracted with Chicago for supply of 2 m.g.d. at 62½ cents per 1000 cubic feet, and has constructed 2 m.g. circular concrete reservoir with tunnel to carry inlet main under Grand Calumet River. There are now 33 suburban or outlying towns supplied by Chicago, aggregate consumption being 17½ m.g.d.—*R. E. Thompson.*

Computing Backwater Curves for Surface Slopes in Streams. J. C. Stevens. Eng. News Rec., 95: 550–2, October 1, 1925. Method suitable for irregular channels described.—*R. E. Thompson.*

Financing Main Pipe Extensions by Assessment Method. Caleb Mills Saville. Eng. News Rec., 95: 471, September 17, 1925. Brief data on financing main extensions in Hartford, where assessment method has been used for several years, given. A 75-foot exemption is allowed on corner lots, and street intersection costs are paid for by city.—*R. E. Thompson.*

Municipal Watershed Reforestation in New York State. Eng. News Rec., **95:** 475, September 17, 1925. Forty cities in New York State are participating in reforestation movement and have in excess of 10,000 acres of young forests, most of which are planted on watersheds. Rochester has been active in forestation since 1909 and its watershed contains 1,086,000 trees. Glen Falls began planting in 1910 and intends to cover entire watershed. Hills around Saratoga Springs contain 1,290,000 trees. Troy has planted half million and Little Falls almost as many.—*R. E. Thompson.*

Some Features of Filter Design. JAS. W. ARMSTRONG. Eng. News Rec., **95:** 470–1, September 17, 1925. Since construction of Loch Raven Reservoir (Baltimore) maximum 20 degree count has been reduced from 800,000 to 13,000 per cubic centimeter and maximum turbidity from 5,000 to 200 p.p.m. Maximum temperature has been reduced 6°F. To obtain maximum efficiency with coagulation, water should be violently agitated immediately after addition of coagulant. Later agitation is ineffective. Experiments carried out at Baltimore with mixing basins of around-the-end type with 13 180° turns showed a distinct gain in subsiding value of the water at each successive turn. Reinforced concrete in contact with water has been found to have tendency to disintegrate, particularly in cold climates, two important factors being quality of sand and imperviousness of concrete. Seepage of water through concrete, particularly where subject to frost action, will lead to ultimate disintegration. Water of pH value less than 7.5 and alkalinity less than 100 dissolves calcium carbonate from concrete, and aluminum compounds also slowly go into solution, resulting in loss in strength, rapidity of destruction depending largely on porosity.—*R. E. Thompson.*

Eugene, Ore. Eng. News Rec., **95:** 472–3, September 17, 1925. Water dept. is under control of water board and is operated, as much as possible, like private corporation. All city services are metered and billed in same manner as private consumers—there is no "free service." Supply is at present drawn from Willamette River, but supply from McKenzie River will shortly be substituted. Maximum demand is 3–4 m.g.d., and average per capita consumption, 110 gallons daily. Douglas fir in wood-stave pipes of distribution system is in excellent condition after 16 years' service, but spiral steel wire binding has deteriorated in some places close to electric railway lines, due probably to electrolysis, deterioration being confined to under side of pipe, where bands were completely destroyed although no rust or corrosion was evident on other parts of same wraps.—*R. E. Thompson.*

Drains Under Earth Dams. C. C. DALAL. Eng. News Rec., **95:** 483, September 17, 1925. Discussion of employment of drains under earth dams and of line of saturation of undrained dams. Drains favored only where signs of sloughing are evident.—*R. E. Thompson.*

Bronze Welding Procedure for Cast Iron Pipe. Eng. News Rec., **95:** 566, October 1, 1925. Bronze welded joints, because of their equally strong structure and lower forming-temperature, have advantages over cast iron welded

joints, especially under field conditions. Of 22 bronze welded pipe lines laid in 1924 in widely separated parts of North American Continent, 12 showed no defects, 8 had minor defects only, and 2, serious defects, latter being attributed to acknowledged porosity and laminations at end of pipe which contributed to defective weld. Code of field rules derived from collected data included.—*R. E. Thompson.*

Penstock Air Valve. Eng. News Rec., **95:** 567, October 1, 1925. New air valve manufactured by Coffin Valve Co., Boston, Mass., described and illustrated.—*R. E. Thompson.*

Water and Water Supplies. H. S. HANCOCK, JR. Pub. Health J. (Can.), **16:** 36–42, 1925. Early history of public water supplies is outlined, and supply of Fort William, Ont., derived from Loch Lomond, 6 miles from city, is described. —*R. E. Thompson.* (*Courtesy Chem. Abst.*)

Ten Million Gallon per day Filtration Plant for the City of St. Catharines. Cont. Rec., **39:** 366–8, 1925. Owing to increasingly unsatisfactory bacteriological quality of present water supply, derived from Welland Canal, city of St. Catharines has contracted for installation of 10-m.g.d. filter plant, brief details of which are given. Works were designed as part of proposed zone scheme for number of municipalities deriving supply from same source, with estimated requirements of 16 m.g.d. in 10 years' time.—*R. E. Thompson.* (*Courtesy Chem. Abst.*)

Peaty Stains in Water. Munic. Eng., **76:** 246, 1925. As result of complaints from textile firms and domestic consumers regarding color of water from Chellow Heights reservoir, Bradford, Eng., Corporation has contracted for installation of coagulation basins and 12-m.g.d. rapid sand filter plant, to be operated at rate of 93 gallons per square foot per hour. Effluent will be passed through existing slow sand filters. Installation is similar to 48-m.g.d. plant under construction for Metropolitan Water Bd., and 3-m.g.d. plant at Kilmarnock. Rate of filtration at latter works is 72 gallons per square foot per hour, and operation is controlled by observation of color of effluent, which is passed through inspecting boxes lined with white glazed tile.—*R. E. Thompson.* (*Courtesy Chem. Abst.*)

The Purification of Swimming Bath Water. Munic. Eng. **76:** 217, 1925. Purification of water of municipal pools of St. Helen's, of which there are 2, of aggregate capacity of 112,000 gallons, is effected by filtration through Paterson pressure filters after addition of coagulant, aëration with compressed air, and chlorination with Chloronome apparatus at rate of approximately 0.5 p.p.m. Water is circulated at rate equivalent to complete replacement every 10 hrs., and is heated to 72° F. in summer and 78°F. in winter. After 19 weeks continuous use, examination showed B. coli and B. enteritidis sporogenes to be entirely absent, total number of bacteria per cubic centimeter on gelatin, 3 days incubation, being only 112. There was no trace of free Cl_2 or of nitrites, and free and albuminoid ammonia and O_2 absorbed in 3 hrs. at 37° were 0.0046,

0.0058 and 0.045 parts per 100,000 respectively.—*R. E. Thompson.* (*Courtesy Chem. Abst.*)

Some Observations on Endo's Medium. Norman MacL. Harris. Pub. Health J. (Can.), **16**: 326, 1925. Of 4 basic fuchsins examined with regard to suitability for use in Endo medium, one consisting of approximately equal proportions of rosanilin and para-rosanilin gave best results. Difco bacteriological peptone was found superior to 6 other brands tested for this medium. Substitution of 0.3 to 0.5 per cent K_2HPO_4 for meat extract in formula of Standard Methods (A. P. H. A.) is recommended.—*R. E. Thompson.* (*Courtesy Chem. Abst.*)

Deep Well Supply for Cochrane, Ont. J. Lanning. Cont. Rec., **39**: 782–4, 1925. New supply of Cochrane, consisting of 2 Layne gravel wall wells and necessary pumping equipment, is described briefly and illustrated. Former supply, originating in springs, was abandoned as result of typhoid epidemic of 1922–3 (cf. this Journal **10**: 725).—*R. E. Thompson.* (*Courtesy Chem. Abst.*)

What is the Present Trend in Water Works Design and Operation? Wellington Donaldson. Cont. Rec., **39**: 854–7, 1925. Review and discussion of trend of water works practice with regard to aëration, sedimentation, coagulation, chemical application, filter sand bed, filter auxiliaries, and chlorination.—*R. E. Thompson.* (*Courtesy Chem. Abst.*)

Public Swimming Pools in the City of Edmonton. Cont. Rec., **39**: 654–5, 1925. Three municipal pools in Edmonton, Alta., are described briefly. Water is circulated every 18 to 24 hours and is purified by filtration and chlorination with bleach, latter being controlled by o-tolidin test. Copper sulfate is used in small quantities to control algae growths.—*R. E. Thompson.* (*Courtesy Chem. Abst.*)

Safeguarding Bathing Beaches. Anon. Public Health News (N. J.), **10**: 121–5, 1925. Majority of N. J. resorts discharge treated sewage to sea through outfall pipes 1000 to 1300 feet long to deep water. Essential that pipe be tight. Allenhurst laid Universal pipe by means of wheeled skid resting on bottom. Neptune township, near Ocean Grove, used 16-inch galvanized wrought iron pipe screwed together in 20-foot sections with 6-inch screwed couplings. Pipe was assembled on beach and pulled to sea by lighter and winch. Sea anchor and gooseneck were placed by divers.—*Jack J. Hinman, Jr.* (*Courtesy Chem. Abst.*)

Muncipal Water Softening. W. C. Hirn and E. F. Eldridge. Public Health (Michigan), **13** (n.s.): 163, June, 1925. Discussion of development of municipal water softening in United States and statements of costs.—*Jack J. Hinman, Jr.* (*Courtesy Chem. Abst.*)

The Filter Plant and the Public. Walter A. Sperry. Public Health (Michigan), **13** (n.s.): 51–58, February, 1925. Experiences and observations

on starting new filter plant in community accustomed to another sort of supply. Publicity as aid to overcoming prejudice and acquainting public with advantages of new supply.—*Jack J. Hinman, Jr.* (*Courtesy Chem. Abst.*)

Iodine Content of the Public Water Supplies of New Jersey. LeRoy Forman. Public Health News (N. J.), **10:** 164–5, May–June, 1925. None contain much iodine. Range from 0 to 8 parts per billion. It is recommended that more marine food, which is high in iodine, be used.—*Jack J. Hinman, Jr.* (*Courtesy Chem. Abst.*)

Vacation Typhoid. Thos. G. Hull. Illinois Health News, **11:** 201–4, July, 1925. August, September, and October showed greatest number of typhoid deaths during 5-year period, 1918–22. Vacation typhoid is not just a term. It really occurs. Several epidemics at resorts are cited. Precautions necessary to take the place of protection offered in cities by health authorities are detailed.—*Jack J. Hinman, Jr.* (*Courtesy Chem. Abst.*)

A Chemical Investigation of the Water of Devil's Lake, No. Dakota. G. A. Abbott. Proc. Indiana Acad. Sci., **34:** 181, 1924. Water of this lake, containing 15,000 p.p.m. total solids, chiefly Na_2SO_4, NaCl, $MgSO_4$, seemed more toxic to fish than its composition indicated. Careful analysis showed 15 p.p.m. zinc. Experiments on fish using this concentration of zinc killed in 8 hours; controls were unaffected. Source of zinc believed to be leeching of zinc salts from treated railroad ties.—*Jack J. Hinman, Jr.* (*Courtesy Chem. Abst.*)

The Genesis of the Ohio River. Gerard Fowke. Proc. Indiana Acad. Sci., **34:** 81–102, 1924. The Ohio came into being through glacial disarrangement of pre-glacial drainage at and near margin of glacial limits, between Mississippi and Kanawha rivers. Divides between the streams were broken down in escape of ponded waters. Irregularity of course is due to Ohio utilizing beds of a number of these pre-glacial streams.—*Jack J. Hinman, Jr.* (*Courtesy Chem. Abst.*)

Analysis of the Thermal Waters of Chaudesaigues, Cantal. Ch. Lormand. Compt. rend., **180:** 450–1, February 9, 1925.—*Jack J. Hinman, Jr.* (*Courtesy Chem. Abst.*)

Influence of the Oxygen Content of Water upon the Respiration of Submerged Plants A. Hee and R. Bonnet. Compt. rend., **180:** 457–9, February 9, 1925. Intensity of respiration is not sensibly influenced by variation in oxygen of water, in fresh water algae studied.—*Jack J. Hinman, Jr.* (*Courtesy Chem. Abst.*)

The Failure of the Bouzey Dam. Vladimir de Belaevsky. Compt. rend., **180:** 422–5, February 9, 1925. Failure was due to tearing away of dam and not to shearing stresses.—*Jack J. Hinman, Jr.* (*Courtesy Chem. Abst.*)

Remarks upon the Salinity Curve of the Waters on the West Coast of Morocco. A. Gruvel. Compt. rend., **180**: 681, March 2, 1925. NaCl increases with depth in Mediterranean and Atlantic with less salty water below at 4000 to 5000 meters. Off coast of Morocco chlorine increases with temperature and is inverse of normal. Similar conditions have been found by Prince of Monaco in Gulf of Gascony and near Azores.—*Jack J. Hinman, Jr.* (*Courtesy Chem. Abst.*)

On the Absorptive Power of Agar-agar. Jean Effront. Compt. rend., **180**: 29–33. January 5, 1925. According to Samec and Ssajevic agar should be looked upon as a sulphuric ether of gelose. Agar absorbs acids, alkalies, and metallic salts; but these may be accounted for in the ash. Nature of agar is considered to be more like a lactone.—*Jack J. Hinman, Jr.* (*Courtesy Chem. Abst.*)

Rapid Determination of Sulphuric Acid in Water. L. Wandenbulcke. Compt. rend., **180**: 515–517, February 16, 1925. Based on property of K_2CrO_4 to precipitate $BaCrO_4$ from $BaCl_2$, and to give an alkaline reaction to methyl red. Bicarbonates, which are also alkaline to methyl red must first be destroyed. As a preliminary, acidify exactly with N/10 HCl: then add a few drops more to bring to pH 4.5 using bromphenol blue. Then take 2500 cc. H_2O under test, and add amount N/10 HCl required as determined above. Add 10 cc. 2 per cent $BaCl_2$ and boil 5 minutes to drive off CO_2. Cool. Add 1 cc. methyl red (0.01 per cent) and add drop by drop 0.7 per cent K_2CrO_4 to end point (yellow). It is necessary to run a blank determination using the same quantities of reagents.—*Jack J. Hinman, Jr.* (*Courtesy Chem. Abst.*)

Radioactivity of the springs of several stations in the Alps (Aix les Bains, Calles les Eaux) of the Pyrenees (Bagneres de Bigorre) of Cevennes (Lamalou les Bains, Balaruc les Bains, Les Fumades) and of natural gas of Vegeze (Gard) of Herepian and Gabian (Herault). Robert Castagne. Compt. rend. **180**: 510–512, February 16, 1925.—*Jack J. Hinman, Jr.* (*Courtesy Chem. Abst.*)

Hydrogen-Ion Concentration of Sea Water in its Biological Relations. W. R. G. Atkins. J. Marine Biol. Assoc., **12**: 717–71, 1922. From Chem. Abst., **17**: 1845–6, May 20, 1923. General description of H-ion concentration, its meaning and methods of determining in sea water given. Conclusions: (1) Salt error of cresol red for sea water of salinity 35 per 1000 is pH 0.18 when determined with Clark and Lubs' standard borate buffer mixtures and compared with McClendon's set as corrected by potentiometer measurements. Measurements are believed to be accurate to pH 0.01. To attain this accuracy indicator must be measured with exactness, not by drops. (2) Sea water may become as alkaline as pH 9.7 as result of very active photosynthesis. This it does in virtue of presence of magnesium salts, since limiting pH value of magnesium carbonate is 10.0, as for magnesium hydroxide. Calcium carbonate as pure calcite gives limiting value of 9.0. (3) pH value below 7.6 in salt water in aquarium tanks denotes abnormal excess of carbon dioxide; at 7.3 symptoms of distress may appear among fishes; and at 7.1 water is foul and bad smelling. Water around seaweed in jar may be as acid as 6.4

Agitation with air removes carbon dioxide and increases pH to 8. (4) In open sea between July and December pH varies between 8.27 and 8.14. April figure was 8.24. Storm, by mixing carbon dioxide with water, may reverse normal gradient. (5) From change in titration value it is estimated that minimum amount of carbohydrate photosynthesized as dextrose is 1 kgm. per square meter of surface between July and December. **Respirable Organic Matter of Sea Water.** Ibid. 772–80. (1) On storing, sea water suffers decrease in pH, change being equivalent to 1.0–3.0 cc. 0.01 N. acid to 100 cc. sea water. Decrease is caused by production of carbon dioxide by organisms. (2) Change corresponding to 1 cc. of acid as above is equivalent to that produced by complete oxidation of 3 mgm. per liter of hexose sugar, which requires 3.2 mgm. per liter of oxygen. This does not agree with usual results for oxygen consumed by alkaline permanganate method. Difference is attributed to respiratory changes taking place during storage which set free much organically combined carbon before oxidation by permanganate has been started. (2) It is probable that change in pH on storing indicates amount of plankton present, assuming absence of sewage. (3) Total amount of carbon, calculated as hexose, which is set free during storage by respiration in sea water 20 miles out from Plymouth is about twice that photosynthesized between July and Dec. **Dibromothymolsulphonephthalein as a Reagent for Determining the Hydrogen-Ion Concentration of Living Cells.** Ibid. 781–3. Brom thymol blue may be used in dilute solution for ascertaining pH of marine organisms. It penetrates slowly, but stained portions remain actively motile. **Hydrogen-Ion Concentration of the Cells of Some Marine Algae.** Ibid. 785–8. **Influence Upon Algal Cells of an Alteration in the Hydrogen-Ion Concentration of Sea Water.** Ibid. 789–91. **Preparation of Permanently Non-Acid Formalin for Preserving Calcareous Specimens.** Ibid. 792–4. Formalin which is permanently non-acid and only slightly akaline (close to pH 9) may be prepared by addition of borax to diluted formalin until bright red is shown with phenolphthalein or slaty blue with thymol blue.—*R. E. Thompson.*

Blue Lead as a Rust Preventative. Anon. Gas-Age-Record, **51:** 301–3, 314, 1923. From Chem. Abst., **17:** 1894, May 20, 1923. Sublimed blue lead is a basic sulphate of lead obtained from fumes produced in smelting galena ore. Tests over period of 6 years gave it a rating exceeded only by basic chromate of lead. Mixed with pure raw linseed oil and not more than 5 per cent by weight of drier, it will form coating with modulus of elasticity far above that required by any deformation due to expansion of metal. One gallon of mixture will cover approximately 800 square feet. It is not affected by heat or cold within range of normal atmospheric conditions nor by sulphur or carbon dioxide present in atmosphere.—*R. E. Thompson.*

Purification of Water. F. Diénert. Compt. rend., **180:** 1228, 1925; Bul. mens. office internat. d'hyg. publ., **17:** 684, 1925. There is a spontaneous underground purification of water by chemical processes in which ferrous and manganous salts take part. It includes the disappearance of dissolved O and NO_3. Such water may also contain H_2S and may be almost or quite sterile. A test may be made by taking 500 cc. of water and 10 grams each FeS and

chalk. After 8 days contact it is sterile. One condition is that the water be of low organic content. Biological purification requires ripening of filters. Submerged filters require a coating of algae, diatoms and bacteria. Non-submerged filters require 60 days to get into shape to remove Bact. coli, 8 days to nitrify NH_3 and 9 days to destroy phenol, according to observations. Such a prepared filter may purify water containing 1 or 2 p.p.m. phenol, an important matter in connection with chlorination.—*Jack J. Hinman, Jr.* (*Courtesy Chem. Abst.*)

Sterilization of Water by Ultra Violet Rays. F. DIÉNERT. Ann. d'hyg. publ. indust. et sociale, **10:** 586, October, 1924; Bul. mens. office internat. d'hyg., publ., **17:** 321, 1925. Henderson, Ky., and Wegandotte (Wyandotte ?). Michigan, are reported as American installations. Installations in France are noted at Maromme, near Rouen, and at Ille sur Sorgues. Monaco also has a plant. 25 to 30 watts per cubic meter is current consumption. It will be necessary to construct a lamp of following characteristics before process will be satisfactory in every way: (1) Automatic lighting without tilting; (2) maximum power developed as soon as lighted; (3) constant and uniform activity of ultra violet rays; (4) non-metallizing of lamp; (5) same intensity of ultra violet light during entire time of functioning; (6) least possible current consumption; (7) operation at high voltage; (8) low price. Bibliography is appended.—*Jack J. Hinman, Jr.* (*Courtesy Chem. Abst.*)

A Bacteriological Study of Soda Water. LEROY FOREMAN. Public Health News (N. J.), **10:** 228–230, September, 1925. Duplicate samples were collected. One bottle was tested at once for bact. count and Bact. coli: second one week later. First batch showed such good results that some bactericidal ingredient was sought. Succeeding samples after planting were seeded with 24-hour culture of Bact. coli. 75 per cent of inoculated samples failed to show increase. Blanks with water showed about 500,000 organisms. Acidity as citric acid, solids from immersion reading, dyes used for coloring, and artificial ethers showed no relation to bacterial condition. Total CO_2 was determined. Conclusions were that no single constituent was responsible for condition shown but that CO_2 content was most potent single factor.—*Jack J. Hinman, Jr.* (*Courtesy Chem. Abst.*)

Purification of Drinking Water of Surface Origin. O. PFEIFFER. Gas u. Wasserfach, **68:** 470–476, 1924; Bul. mens. office internat. d'hyg. publ., **17:** 556–557, 1925. Magdeburg (Puech-Chabal plant) uses degrossisseurs and sand filters. Chlorine introduced prior to slow sand filtration gave excellent results. Enough chlorine was applied so that samples collected half way through filter bed would give test for free chlorine by KI-starch method.—*Jack J. Hinman, Jr.* (*Courtesy Chem. Abst.*)

Eijkman Reaction Negative in a Water Containing Bact. Coli. GROETSCHUL. Centralbl. f. Bakt., **92:** 47, 1924; Bul. mens. office internat. d'hyg. publ., **17:** 557, 1925. Some waters tested by Eijkman process (Dextrose broth planted with water under test and incubated 24 hours at 46°C.) gave no gas

production, but gave positive tests by other methods. Besides the usual causes for error (such as too few organisms, and strains failing to produce gas at 46°C.) failure to produce evident gas is ascribed to reduction of NO_3 to NO_2 by H, and to solution of CO_2 produced.—*Jack J. Hinman, Jr.* (*Courtesy Chem. Abst.*)

On the Control of the Chlorine Apparatus of the Indoor Swimming Pool of Frankfort. AL. GERSBACH. Gesundheits Ingenieur, **47**: 57, 1924; Bul. mens. office internat. d'hyg. publ., **17**: 89–90, 1925. Pool of 750 cu. m. capacity has its water recirculated in 12 hrs. Filters and chlorination to extent of 0.3 p.p.m. Cl are used. After 10 months' recirculation water was as satisfactory as that of a women's pool which was filled weekly but not disinfected. Water is changed more frequently on account of algae which grow in joints of tile flooring although pool is cleaned mechanically daily.—*Jack J. Hinman, Jr.* (*Courtesy Chem. Abst.*)

Metropolitan Water Board. 19th Annual Report on the Results of the Chemical and Bacteriological Examination of the London Waters for the Twelve Months ended March 31, 1925. Sir ALEXANDER HOUSTON. Introduction reviews work of water examination department since November 1905. Amongst matters dealt with during past year were chlorination of Thames and New River waters, taste experiments, suspended solids in Thames water during different periods of year, pre-filtration waters, increased rates of filtration using primary rapid sand filters, presumptive B. coli test, 1924–1925 river floods, aids to differentiation of bacterial types, value of permanganate, B. Welchii gastro-enteritis and water supply, condition of Thames as regards dissolved oxygen, resistance to filtration and microscopical appearances of pre-filtration waters, sterilisation of new mains, complaints from consumers, excess lime method, iodine in water, prolonged storage, and meteorological notes. Report is so exhaustive that abstract work cannot do it justice. *Chlorination of R. Thames water.* Structural changes during year introduced new and difficult factors in successful treatment of Thames River supply. Water after chlorination occasionally developed iodoform taste. At such times permanganate plant was put in operation with completely successful results. This plant was put in commission in anticipation of taste occurring in the filtered water. Not a single taste complaint was received from consumers. Permanganate treatment occurred on 18 days during year. During 1924–25, raw water after treatment showed B. coli present in 65.6 per cent of samples in 100 cc. and only 33.1 per cent positive in 10 cc. Figures are higher than in previous years, due to turbid and flood water conditions extending over prolonged periods. Bearing in mind quality of water before treatment results are regarded as very satisfactory. As result of pre-chlorination the "number of acres of filter beds cleaned" has been greatly reduced, figures showing reduction of 31 per cent between 1915 and 1925. In stored waters chlorine is regarded as algicidal, as well as bactericidal agent, but unlike copper sulphate, it is more efficacious for latter purpose. HOUSTON states that "the inhibitory effect of chlorine wears off, and if the water is stored long enough and the reservoir is infected from new or old growths, a further development may

take place." Chlorination of 26,269.4 millions of Thames water was made during year, in which 121.58 tons of bleach, 4.8 tons of liquid chlorine, and 0.13 ton of permanganate were used, at a cost for chemicals of approximately $5900 and a net saving in operating costs of $59,300. Average dose of chlorine applied was 0.43 parts per million. The average percentage of available chlorine extracted from bleach was 37.22 per cent. *Chlorination of New River supply.* In spite of abnormally bad water conditions, New River was successfully treated on 291 days during year, no complaints of taste being received. Very close laboratory control was necessary to achieve this. Average dose of applied chlorine was 0.353 parts per million. Permanganate treatment for taste prevention took place on 281 days when an average dose of 0.21 part was applied. Total cost of chemicals amounted to 45 cents per million imperial gals. of water. treated. *Taste experiments.* Details are given of laboratory experiments on general well at Ferry Lane works upon dilution of water susceptible to taste after chlorine treatment. Dilution as high as 80 per cent untreated mixed with 20 per cent treated water failed to dissipate or obscure taste. Experiments also included chlorination followed by dechlorination with sulfur dioxide. HOUSTON says "It is obvious that the treatment of a water, like the Ferry Lane supply, presents serious difficulties. In order to secure immunity from taste troubles, either costly super-chlorination methods would have to be employed, or the risk run of incomplete sterilisation by resorting to a minor dose of chlorine." The untreated water had a slight earthy taste, which was not appreciably modified by treatment. In no case, however, was there any iodoform taste, in striking contrast to the ADAMS' results, so it is obvious that some waters, at all events, are more prone to taste troubles *after*, as compared with before filtration. It is difficult to say how such a water (water treated with chlorine before filtration) would behave as result of filtration process. Possibly, or probably, earthy taste would be removed and a tasteless water result. On the other hand if there were any latent taste, this might be at first adsorbed in filter bed, and later on become apparent in filtrate. At all events, results are sufficiently striking to lead one to doubt wisdom of unconditionally recommending postfiltration chlorination; indeed it might be argued that they point somewhat strongly to desirability of chlorinating before filtration. *Consideration of Adams's results.* Three pages are devoted to work (English) of ADAMS and of THRESH and BEALE and some twenty-one pages to exhaustive researches by HOUSTON himself. Original article of B. A. ADAMS which appeared in The Medical Officer (England) **33**: 12, 869, entitled "The iodoform taste acquired by chlorinated water" is considered so important that it is reproduced in full. Included in ADAMS's text is statement "It appears to be generally known that this iodoform taste can be imitated by chlorinating a water containing a trace of phenol, but this fact is not widely published, neither are there any details on this point." [In America, where much work has been carried out on chloro-phenoloid tastes, this statement will not be well received. Detailed figures were published in this JOURNAL as far back as 1922 and since that date many others.—ABSTR.] Summary of ADAMS's results: (1) There is some constituent in the atmosphere at certain times and places, which combines with chlorine added to a water and causes iodoform taste. (2) This constituent is probably

of phenoloid character derived from gasworks and from imperfectly burnt coal. (3) This reaction does not take place if water contains a trace of free ammonia. (4) Nor does it take place if chlorinated water is not exposed to air, or if water contains an unusual amount of organic matter. (5) Chlorinated water should not be exposed to air, at least in proximity of towns or gas works, nor afterwards be mixed with water which has been so exposed. HOUSTON who is familiar with much of the American work adds "As regards (4) it would perhaps be better to add after the words 'not exposed to air' the words 'or contaminated with liquids containing phenol bodies.'" Some details of work of Drs. THRESH and BEALE on "The taste and odor of chlorinated waters" are included and summarised as follows: (1) Taste is more persistent than odor. (2) There are marked differences between individuals with reference to taste sensitiveness; women appear to be more sensitive than men. (3) Both men and women could detect taste at a dilution of 1 in 40 millions. (4) The majority (women in this case) could detect it at 1 in 2000 millions. (5) Some could unhesitatingly detect it at 1 in 5000 millions. (6) At 1 in 10,000 millions, no taste could be detected. 37 of HOUSTON's own experiments are given in full; possibly the most complete of their kind ever published. They are summarised as follows:—(1) London air contains substances which, when absorbed by water react with chlorine to produce iodoform taste (see experiment 6). Presence of "particulate" matter does not appear to be essential factor in provoking taste (see experiment 4). (2) Rain water in London may absorb enough of these substances to give, when added to tap water in proportion of 1 per cent, iodoform taste in presence of free chlorine (e.g., experiments 24, 25, and 26). (3) Carbolic acid, in proportion of 1 part to one thousand million parts of water, can, in presence of free chlorine, produce iodoform taste (experiments 27 and 28). Vapours derived from such substances as izal and lysol have strong taste-imparting qualities (see experiments 20 and 21). These experiments also show that if izal-, or lysol-, contaminated air is first passed through alkaline permanganate, its taste provoking quality is practically removed. (4) There are several taste preventers, or taste removers. These include organic matter, potassium permanganate, ammonia and ammonium salts, superchlorination and dechlorination. Light and sunshine have a slight effect in removing iodoform taste from water. Aëration is not of much value. Conclusions drawn are that superchlorination and dechlorination, apart from question of expense, are uniformly successful. The more chlorine that is added, the more certain is absence of taste after dechlorination. Ammonia is a taste preventer, and permanganate both a taste preventer and a taste remover. A diagram (see diagram 1) is given showing the number of pounds of chlorine, sulphur dioxide, permanganate, and nitrogen (ammonia) to be added per million gallons of water treated, to correspond with a wide range of doses, and approximate cost involved in each case. As to which is the best method to adopt when dealing with taste conditions, HOUSTON states "The question cannot be answered satisfactorily. Each case must be judged on its merits. When the circumstances are such that only a short period of contact is possible, the water perhaps seriously polluted and, as well, likely to cause taste troubles, perhaps due to phenol pollutions and relative absence of organic matter as a corrective

factor, and economical considerations are not dominant factors in the situation, superchlorination and dechlorination methods should be carefully considered. In cases when questions of taste are almost certain to arise, the duration of contact adequate, and arrangements as regards scientific supervision satisfactory, the use, in conjunction with chlorine, of permanganate or, ammonia (or its compounds), as taste preventers, should receive special consideration. Permanganate has the advantage of being a taste remover as well as a taste preventer and of assisting sterilisation without producing "lagging" effects. Ammonia apparently causes a "lag" in the sterilisation process, but increases its ultimate effect. Moreover, in the case of waters containing very little oxidisable matter and possessing little or no color, the use of ammonia would seem to present special advantages." *Suspended solids in R. Thames water.* Suspended solids determined gravimetrically weekly. During 12 weeks, total solids were less than 100; during 16 weeks, between 100 and 200; during 12 weeks, between 200 and 300; during 10 weeks, between 300 and 400; and during 2 weeks, between 400 and 500 pounds per million gallons respectively. *Pre-filtration waters.* These are the waters previous to filtration, which have undergone some system of treatment, either sedimentation, resulting in devitilisation or attenuation of pathogenic organisms, rapid filtration, or chemical treatment. The great mass of water was improved 10 times, a goodly proportion of it 100 times, and a small amount actually 1000 times, as judged by B. coli tests. On a proportional basis, number of bacteria in raw water was reduced 85.8 per cent. B. coli figures show 78.3 per cent of raw water positive in 1 cc. or less, while 28.7 per cent of pre-filtration waters contained no B. coli in 100 cc. Chemically, reductions are shown in ammonia and albuminoid nitrogen, oxygen consumed, turbidity, and color. "The loss of vitality of pathogenic microbes has been carefully correlated with certain physical, chemical, and bacteriological changes which occur in river water as a result of adequate storage; so it comes about that by the analysis of the pre-filtration waters, it is possible to deduce a margin of safety previous to filtration. The chemical results in this question, are of real value. It is not merely a question of percentage improvement, but an alteration in ratio; thus the ammoniacal nitrogen, turbidity, and color tests show greater reductions than the albuminoid nitrogen and permanganate tests. It takes time to bring about these changes, and all bacteriologists know the profound influence of time in destroying the vitality of pathogenic bacteria." *Barn Elms experiments.* Brief reference is made to these experiments where nine rapid sand units are in use. It was considered desirable to try the effect of much higher rates of filtration (ordinary rate 120 gallons per square foot per hour), but this for mechanical reasons was found to be impracticable. Four experiments carried out in miniature filters are described and conclusions drawn are: "Apart from questions of quality (not dealt with here), the life between successive cleanings of a filter and the volume of water filtered can be materially increased by the preliminary removal by rapid filtration of most of the growths and much of the suspended matters. . . . . The writer, however, is mainly concerned with questions of quality and although the results of new procedures may possibly lead to the consumer receiving a water less perfect in physical and chemical sense, he is not unprepared to condone these imper-

fections provided always the position is rendered as safe, or safer, bacteriologically and epidemiologically. In this connection, chlorination, or some other form of sterilisation, should be regarded as the supreme factor making for safety. Conceivably, chlorination may only be needed as a stand-by measure, but the necessary plant should undoubtedly be installed and used in connection with the large new schemes looming in the near future, permanently, or until the last shred of doubt of the perfection of the new arrangements has been finally and absolutely established." *Three star (***) presumptive B. coli test.* Rapid method for judging quality on bases of presumptive test in 10 and 1 cc. portions. Quality of bile-salt used for this test has been found to be non-selective since the war. Ten cc. and 1 cc. cultures of water are made into double and single strength liquid lactose bile-salt medium respectively. Tubes are placed in warm water (37°C.) for a few minutes, and then transferred to incubator (37°C.). After 24 hours they are examined. If there is gas formation in both tubes sample is considered unsatisfactory, and no further tests made, it being assumed that reasonably pure water would not give positive result within 24 hours with so small an amount as 1 cc. and, further a 1 cc. positive presumptive result probably indicates a 10 cc. confirmatory result. If 10 cc. positive and 1 cc. negative, water is objected to and further procedures carried out. The 10 cc. tube is subcultured into lactose broth and peptone water, indole test being regarded as essentially typical of B. coli. Following is for rapid judging and starring: *Primary cultures.* (*a*) Both tubes negative. Water passed unconditionally. No stars. (*b*) Both tubes positive. Water objected to unconditionally. Three stars (***). *Secondary cultures.* (*c*) Lactose negative, indole negative; and (*d*) lactose negative, indole positive. Water passed provisionally. but question of further samples considered. One star *. (*e*) Lactose positive, indol negative. Water objected to, but not absolutely condemned, two stars, **. (*f*) Lactose positive, indole positive. Water objected to unconditionally. Three stars ***; same as (*b*). Foregoing classification is suggestive merely, and may be modified in great variety of ways to suit particular circumstances, or meet views of individual workers. For example, sets of three, five, or even ten tubes may be employed and conclusions based on number giving positive results, perhaps 2 out of 3, or 3 out of 5, or 6 out of 10. *Aids to differentiation of bacterial types.* Reviews work of Koser on use of a citrate medium as aid to differentiation of members of colon group; also recent conclusions of Brown, Duncan, and Henry (Journal of Hygiene, XXIII, No. 1). Conclusions reached on London waters were, that citrate test would not be of much value in connection with ordinary examination. With "lactose + and indol +" microbes, citrate test yielded negative results, but with some coli-like forms non-typical in character, negative results were also obtained. In general, citrate test confirmed significance of "lactose + indol +" microbes, but sometimes failed to exclude non-typical varieties. Experiments were made during winter months and opinion is expressed that summer results might be different. It is considered that available evidence (Koser's own work) is in favor of citrate test being of considerable value in judging new and doubtful sources of supply, but caution is desirable. Houston considers some bacteriologists a little too eager to deny recognition to aërogenes group because they are apt to be associated with

washings from grains and soils. Yet it is in times of flood when all sorts of 'unchartable' pollutions are swept into watercourses that these soil microbes may be perhaps specially noticeable and few will deny that floods are periods of epidemiological danger. Take case of Poona (India), as example. Before chlorination was practised, advent of flood water was inevitably followed by water borne epidemics of a most serious kind. Presumably at these periods presence of aërogenes group of microbes and such perfectedly harmless soil bacteria as B. mycoides might be considered indicators not of safety, but of danger. Writer ventures to think that bacteriologists should think first of epidemiology. It would be too much to ask epidemiologists to reverse the position. In striving after common sense both schools have a common playground. *B. Welchii, gastro-enteritis, and water supply.* Houston gives interesting discussion on this subject, but sees no reason for changing his views previously expressed, namely, "The B. coli test is still by far the most reliable and speediest method of judging the degree of efficiency of the particular water purification process under investigation, and when a sterilisation treatment is in operation, the certified destruction of B. coli should afford absolute proof, practically speaking of the devitalisation of all the microbes of epidemic water-borne disease." *Resistance to filtration and microscopical appearances of the pre-filtration waters.* These investigations have now been carried out for past ten years and have been of great operating value. Apart from special photographs, over 11,000 routine photographs have been taken of suspended matter in the water, showing a permanent record of condition of pre-filtration waters from both qualitative and quantitative points of view. Diagram at end of report gives averages for ten years ending March, 1925. *Under the heading of miscellaneous are included variety of subjects. Sterilisation of new mains.* The importance of sterilising new water mains greatly in excess of the normal dose is emphasized. *Complaints from consumers.* All complaints are investigated regardless of distance. Interesting details of one complaint in very old house are given. In this instance the service became infested with minute worms (oligochaetes). No other complaints were discovered in neighbourhood. The drastic remedy of chlorinating whole system of supply in house in question was successfully carried out. Subsequent visits showed that treatment had been completely satisfactory. (Photographs nos. 204 and 205.) *Excess lime method.* Mention is made as to the success in India of this method for destroying cyclops in water: this crustacean being supposed to act as the intermediary host in the development and transmission of guinea-worm embryos to man. Chlorine in permissible doses was not found so useful. *Iodine in water.* Reproduction is made of valuable article which recently appeared in The Medical Officer (England) No. 869. Report concludes with valuable meteorological observations. Ten diagrams covering various conditions arising in the purification and operation are included. Many beautiful photographs are reproduced. Statistics of London supply include the following: Storage reservoirs number 49, cover 2704 acres, and hold 19,657 million imperial gallons. 91 service reservoirs cover 91 acres and hold 322.7 million gallons; 172 filter beds cover 170.7 acres, filter at rate of 2 gallons per square foot per hour. Engines number 274 of total horse power of 44,278. There are 6.725 miles of water mains. Average daily supply is over 250 million

gals. supplying over 7 million people, with per capita consumption of approximately 37 gallons. Eighty per cent of supply is from rivers and 20 per cent from deep wells. Report is most valuable of its kind that is published and contains much new and practical information.—*N. J. Howard.*

Importance of Differentiating Colon-Aërogenes Group in Examining Water. Jack J. Hinman, Jr. Am. J. Pub. Health, 15: 614–9, July, 1925. (Reprint.) General discussion of test for B. coli in water, with special reference to present status of methods for differentiation of colon-aërogenes group and value of information derived therefrom. Author believes that while these methods have definite investigational value, development of subject is not such as to justify attaching too great significance to division of group into-so-called fecal and non-fecal types. Method of differentiation recommended in Standard Methods (A. P. H. A.) is not practical for ordinary routine examination, as time required is prohibitive, results having only historical value when tests are completed. Tabulation of results of examinations of treated water from Iowa plants during 1914–1924 inclusive given, showing that of 18,847 tubes planted, 31.5 per cent gave postive presumptive tests, 9.4 per cent of these being due to presence of *B. coli*, 9.8 per cent to *B. aerogenes*, and 80.8 per cent to other gas formers.—*R. E. Thompson.*

Sodium Hypochlorite. Science, 62: xiv, September 18, 1925. Jean Perrin, before Academy of Sciences, quotes experiments carried out by Philippe Bunau-Varilla and Emile Techoueyre to prove or disprove their theory that germicidal power of sodium hypochlorite is due to germ-destroying invisible rays given off when in contact with organic matter. Quartz tube was filled with dilute solution of sodium hydpochlorite and placed within larger quartz tube, interspace filled with water containing B. coli and whole immersed in hypochlorite solution. Parallel experiment, omitting the disinfectant, was also carried out, and after standing 24 hours water from each was examined by plating on gelatin. In 51 of 60 such experiments, water exposed to hypochlorite solution contained lower number of bacteria.—*R. E. Thompson.*

Rôle of Carbon Dioxide in Corrosion of Iron. T. Fujihara. Chem. and Met. Eng., 32: 16, 810–1, October, 1925. Experiments were conducted to prove that pure water and pure oxygen cannot attack iron on which a protective film has been previously produced, the additional action of carbon dioxide being necessary to produce rust. Other tests were conducted to show that rusting once started will cease if carbon dioxide is excluded. Carbon dioxide plays an important part in corrosion process, but its action is entirely different from that claimed by many investigators. Initial reaction is electrochemical and the carbonic acid later combines with the ferrous hydroxide.—*John R. Baylis.*

A Device for Estimating Corrosion. W. R. Fetzer. Ind. Eng. Chem., 17: 788, August, 1925. Description of equipment used in determination of corrosiveness of various liquids toward metals, etc.—*Linn H. Enslow.*

Fundamental Factors in Corrosion. Geo. M. Enos. Ind. Eng. Chem., **17**: 8, 793, August, 1925. Tendency for a metal to corrode is simply its tendency to lose electrons. Atoms are composed of positive and negative charges of electricity (electrons). Ions are produced when an atom or combination of atoms (molecules) lose one or more electrons. Atoms of metallic iron (Fe^{0}) lose two negative electrons to produce positively charged ions of ferrous iron (Fe^{++}) which in turn lose another negative electron to produce ferric iron (Fe^{+++}). The negative electrons split off neutralize positive charges on hydrogen ions—atomic hydrogen (H^{0}) resulting: thus (1) $Fe^{0} + 2(H^{+}\cdot OH^{+}) = Fe^{++}: (OH^{-})_2 + 2H^{0}$; and (2) $Fe^{++}: (OH^{-})_2 + H^{+}.OH^{-}) = Fe^{+++}: (OH^{-})_3 + H^{0}$. Considered in this light, it is apparent that the oxidation and electrochemical theories agree basically. In tests made on various mild steels there appears to be no relationship between carbon content and rate of corrosion in air or distilled water. Rate of corrosion in air appears to be about 10 times that in distilled water. Rate of corrosion increased in all cases with temperature; rate of increase in cases of dilute sulphuric acid, ferrous sulphate, and distilled water being relatively of same intensity over given temperature range. Difference between extent of corrosion in daylight and that in darkness was inappreciable in tests made. There was indication, however, that light accellerates corrosion to some extent.—*Linn H. Enslow.*

Permanent Standards as Possible Source or Error in Iron Determinations. Edward S. Hopkins. Ind. Eng. Chem., **17**: 8, 832, August, 1925. Permanent iron standards prepared in accordance with proceedure outlined in Standard Methods of the A. P. H. A. give erroneous results. In extreme cases they may indicate only 50 per cent of true quantity of iron present in sample. Error varies between 0.002 and 0.15 mgm. of iron (Fe). Extent of error increases with increase in value represented by the artificial standards. A great deal also depends upon quality and shape of tubes used for the comparison. In all cases, for accuracy permanent standards should be calibrated, or finally standardized against series of solutions of known iron content. [It is essential to follow empirical formulae and use exactly sizes and shapes of tubes recommended in Standard Methods for accurate results. Comparative data presented in article indicate that results of sufficient accuracy were obtained when using 50 cc. Nessler tubes as designated in Standard Methods. Errors appeared when departing from empirical procedure always required to produce artificial permanent standards which are to prove accurate.—Abstr.] —*Linn. H. Enslow.*

A Study of the Chemical Differentiation of Bacteria. Esther W. Stearn and Allen E. Stearn. J. Bact., **10**: 1, 13 January, 1925. Oxidizing agents alter properties of bacteria usually considered as characteristic of a strain. Constituents of media will also react on bacteria, changing their characteristics. In some instances, variation practically amounts to production of a new strain. After 5 months culturing, four different members of B. coli group exhibited identical cultural characteristics. It seems that a change in environmental conditions results in a change not only in chemical constitution of bacteria, but also in characteristics by which they are classified. If previous

history of such altered strains were not known, they might be classified differently after alteration from what would have been the case with fresh strain.—*Linn H. Enslow.*

The Reducing Properties of Microörganisms with Special Reference to Selenium Compounds. Victor E. Levine. Jour. Bact., 10: 3, 27, May, 1925. Selenium dioxide, or sodium selenite, in concentration 1:50,000 or 1:25,000 can be used to demonstrate bacterial reduction in solid sugar-free culture medium. Selenium compounds serve as better indicators for reducing enzymes than organic dyes inasmuch as the reduction to free selenium is an irreversible reaction. Brick red streak follows line of growth of reducing organisms. Selenium agar (0.15 per cent Na_2SeO_3) as culture medium for selective growth of typhoid bacilli is superior to malachite green or Endo agar.—*Linn H. Enslow.*

Adjustment of pH of Culture Media under Sterile Conditions. Leo M. Christensen and Ellis I. Fulmer. Ind. Eng. Chem., 17: 935, September, 1925. Description and illustration of required apparatus for applying sterile acid or alkali to sterilized media. Its use eliminates necessity of re-sterilization with attendant change in pH value usually encountered in sterilization after adjustment.—*Linn H. Enslow.*

Sulfite Liquor as a Protective Colloid. E. C. Bingham, G. F. Rolland, G. E. Hilbert. Ind. Eng. Chem., 17: 952, September, 1925. Sulfite liquor from pulp industry is very efficacious as a producer of emulsions difficult to flocculate. Alum to which alkali had been added was itself deflocculated upon addition of sulfite liquor. No good flocculating agent has been found for suspensions of clay, etc., in sulfite liquor. Added to water or soap solutions, it lowers the surface tension materially.—*Linn H. Enslow.*

Device for Maintaining a Small Constant Flow of Liquid. Chas. Van Brunt. Ind. Eng. Chem., 17: 966, September, 1925. Feeding orifice consists of shallow helical groove of about ten turns around rod which fits snugly in cylinder. Cylinder is stationary; rod is kept rotating in direction which would force solid particles through in like manner to screw conveyer. By this feature clogging is prevented. Exact adjustment of rate of flow is easily secured by moving rotating shaft or fixed cylinder in or out to change number of threads which are operative. Ordinary machine threads are satisfactory if sharp edges are removed in lathe. In cases of corrosive liquids, hard rubber or graphite may be employed.—*Linn H. Enslow.*

Influence of Curvature on Air Saturation of Water and Its Relation to the Air-Binding of Filters. John R. Baylis. Ind. Eng. Chem., 17: 974, September, 1925. Water under pressure which contains sufficient air to produce atmospheric supersaturation will not upon release of pressure contain visible air bubbles until agitated. Water fairly heavily charged with air exhibits milky appearance when drawn from faucets when emerging stream is exposed to atmosphere. By simply submerging faucet outlet when drawing the water,

milkiness is suppressed: thus indicating necessity of aërial contact with emerging stream for release of dissolved air. Considerable supersaturation (probably over 100 per cent) is required to start release of air bubbles on solid surfaces. Were it not for the few air bubbles entrapped with suspended coagulum in water being filtered, there would be little or no danger of air release from supersaturated water in the beds which results in "air-binding." Air bubbles introduced with wash water and not completely displaced from bed during washing are sufficient to start air release from water during subsequent filtration. Once this release is started, air-binding increases very rapidly if supersaturated water is being handled. In design of filter plants great care should be taken to minimize opportunity for supersaturation prior to filtration. More particularly should possibility of entrained or trapped air bubbles reaching filters be prevented. Entry of air with wash water is particularly to be guarded against.—*Linn H. Enslow.*

Advantages of the Use of Lime in Water Softening and Purification. Charles P. Hoover. Water Softening, Published by the National Lime Association, p. 3. Advantage of adding lime to hard magnesium water are as follows: (1) Water is softened; (2) intestinal and pathogenic bacteria are killed; (3) water is clarified; (4) color is removed; (5) corrosion of iron pipes is prevented and trouble from "red water" is eliminated; (6) sterilizing action of lime persists indefinitely, and (7) nothing in reality is added to the water that was not originally there. Experiments in sterilization by softening with lime at Lawrence, Cincinnati, London, Columbus and other Ohio plants are recounted. Average turbidity of 63 in river water at Columbus for 1910, 11, and 12, was reduced to less than 5 p.p.m. after addition of lime, soda-ash and alum, and allowing 12 to 15 hours settling. Advantage of excess ilme treated water, for swimming pools, over water sterilized by hypochlorite or chlorine, is that disinfecting action of caustic persists, and if the water should become contaminated with pathogenic organisms they will soon become attenuated and finally die because of the absence of carbonic acid in the water. Results of carbonization of softened water at various plants have shown that lime softening is entirely practical and economical.—*A. W. Blohm.*

The Cost of Impurities in Locomotive Water Supply and the Value of Water Treatment. C. H. Koyl, R. C. Bardwell, W. M. Barr, O. W. Carrick, R. W. Chorley, R. E. Coughlan, B. W. DeGeer, J. P. Hanley, W. H. Hobbs, P. M. LaBach, O. T. Rees, H. H. Richardson, D. A. Steel, C. P. VanGundy. Water Softening, Published by the National Lime Association, p. 3. Operation of the railroad depends on the locomotive, and efficiency of the locomotive depends principally on the character of the feedwater. A water of 12 to 15 grains per gallon of incrusting solids, is likely to injure the operation of a road to the amount of $2000 per locomotive per year; and the cost rises with the increase of impurities to practically prohibitive figures at $20,000 to $25,000 per locomotive per year. Installation of water softening plants and the savings following their installations for the Wabash Railway; Chicago & Alton; Hocking Valley; Missouri-Kansas-Texas; Illinois Central; Chicago, Milwaukee & St. Paul and the El Paso and Southwestern railroads are presented.—*A. W. Blohm.*

Raw Water Ice—How A Water Analysis Tells the Quality of Ice You Will Make. A. S. Behrman and O. A. DeCelle. Water Softening, Published by the National Lime Association, p. 3. A brief explanation of the physical and chemical characteristics of water, a tabulation showing the minerals in water, their effect in ice, and the result of treatment with hydrated lime and allowable limits of various minerals are given.—*A. W. Blohm.*

What to Expect from Your Water Treating Plant. A. S. Behrman. Water Softening, Published by the National Lime Association, p. 36. The object of water softening is to make better ice and more ice. Two requirements for really satisfactory chemical feed are that lime mixture be absolutely uniform and that it be fed in strictly accurate proportion to the water being treated. Simple chemical tests on treated water should be made frequently, and the indication of the tests followed. Instances are given where faulty operating conditions were responsible for inferior ice and where water treatment unjustly received the blame.—*A. W. Blohm.*

Some Variants from Accepted Formulae in Water Flows. C. Arthur Brown. Water Softening, Published by the National Lime Association, p. 40. Formulae for determining pipe sizes, volume and velocity of flow and discharge through mains and orifices, with examples showing their practical application.—*A. W. Blohm.*

Severe Leak in Victoria's Concrete Water Main Controlled by Flexible Joint. F. M. Preston. Cont. Rec., 39: 46–8, January 21, 1925. Water supply of Victoria is obtained from Sooke Lake through 27¼ miles of 42-inch concrete pipe flow line and 10½ miles of 36-inch riveted steel pressure pipe. Pipe line was completed in 1915 and by 1918 at least 1200 expansion cracks, almost entirely at joints, had developed in concrete section, giving rise to leakage which in December 1919 was as great as 89 per cent, one per cent loss representing 200,000 gallons per day. Fact that pipe line would deliver nearly 3 times amount of water required made situation less serious than it appeared. Repair work was commenced in 1922, 132 joints being placed, average leakage for year being 48 per cent. In 1923, 240 joints were constructed and average leakage was 30.7 per cent, and in 1924, 200 joints were made and leakage averaged 25.5 per cent. There are approximately 700 joints yet to be repaired. Flexible joint was evolved which could be applied to outside of pipe while water was flowing, consisting of 24-ounce copper strip rolled to fit circumference of pipe and extending two-thirds around it, practically to high level water mark in pipe. Strip is 4¾ inches wide and has V-shaped depression, ½ inch deep and ¾ inch wide, formed longitudinally on centre line, and it is attached to pipe with V projection entering into small groove chipped in offending joint, being clamped into place by two 2½-inch round steel rods and turnbuckles. Two 1¾-inch strips of sheet lead form packing material between copper and concrete. To prevent ice formation in space provided for V, this cavity is first filled with putty of castor oil, asbestos fibre, and red lead, which maintains its consistency all year round. Cost of joints in 1924 was as follows: Copper $3.70, lead $1.60, clamps $1.79, putty $1.65, labor $5.92, total $14.67.—*R. E. Thompson.*

Tunnel under Lachine Canal, Montreal. Cont. Rec., 39: 53, January 21, 1925. Tunnel under construction which will join two vertical shafts sunk from surface through approximately 70 feet of quicksand and 30 feet of rock, described briefly. Tunnel, which is 14 feet by 15 feet in section, will carry three riveted steel mains, two 36-inch and one 48-inch, to supply section of Montreal north of canal, which is at present supplied by two 36-inch cast iron pipes laid in bed of canal. Concrete linings will be placed by pneumatic method.—*R. E. Thompson.*

An Interesting Water Works Valve Equipment for Australia. Cont. Rec., 39: 770, August 5, 1925. Brief illustrated description of two 36-inch cast iron Johnson-Boving control valves, weighing 5 tons each, supplied to Sydney water works, New South Wales, for operating at head of 200 feet.—*R. E. Thompson.*

State Grants for Rural Sewage and Water Works. A. J. REDFERN. Munic. Eng., 75: 687, June 25, 1925. Conditions relative to sewage disposal and water supply in rural districts in Great Britain reviewed and financial difficulties discussed. Government grants for relief, through Ministry of Health, advocated.—*R. E. Thompson.*

The Properties of Aluminate Cement. ROGER L. MORRISON. Cont. Rec., 39: 417–8, 1925. Tests of properties of American aluminate cement (Atlas Lumnite Cement Company) indicated that maximum strength is reached in 3 to 5 days, strength of 1:2:4 aluminate cement concrete at 5 days being almost twice that of best 1:2:4 portland cement concrete at 29 days. At 29 days a 1:4:8 aluminate cement concrete has approximately same strength as 1:3:6 portland cement concrete, while 1:3:6 aluminate is approximately as strong as 1:2:4 portland. In practically all cases, strength of aluminate concrete was inversely proportional to the amount of water used. Amount of water required to produce a given slump with aluminate cement was practically same as with portland cement. In almost every case cylinders cured in dry air were stronger than those cured in moist air, the average difference in strength being 7 per cent. An average of 209 pounds per square inch was required to break at end of 24 hours 6 cylinders made by replacing in molds half-briquettes of portland cement and filling rest of space with aluminate cement mortar. Results of setting time tests made upon mixtures of aluminate and portland cements showed that flash set does not occur unless proportion of portland cement falls between 33 and 90 per cent.—*R. E. Thompson.* (*Courtesy Chem. Abst.*)

Condensers of Atmospheric Vapor Supplied Water to the City of Theodosia in Tauride (Crimea) Five Centuries before the Christian Era. Anon. L'Eau, 18: 92–93, 1925. Russian engineers working on water supply for modern town discovered water system leading to springless mountain tops. Investigation disclosed large condensers made of piles of stone 25 meters long, 30 meters wide and 10 meters high. There were thirteen of these in a space of 3 km.—*Jack J. Hinman, Jr.* (*Courtesy Chem. Abst.*)

The Spread of Dysentery Considered from the Aspect of Public Health. PHILIP MANSON-BAHR. J. State Med., 33: 401–414. 1925. Flies, water, and carriers are considered as vectors of infection. Emphasis is placed on carriers in case of bacillary dysentery and on water in case of amœbic dysentery.—*Jack J. Hinman, Jr.* (*Courtesy Chem. Abst.*)

East Durham Water for Boiler and Other Purposes. W. GORDON CAREY. Chem. Ind., 44: 286–290T, 1925. General paper on softening of hard magnesian waters by various methods and including discussion of removal of oil and dissolved gases. Wells 140 to 500 feet deep are source from which 10 m.g.d. are derived. Sanitary quality is good.—*Jack J. Hinman, Jr.*

Report of Measures for the Protection of Underground Waters. A. R. ATKEY, ALFRED B. E. BLACKBURN, A. E. CORNEWELL-WALKER, FRED W. MACAULAY and WM. TERR. Water and Water Eng., 27: 175–180, 1925. Report of sub-committee to Advisory Committee to Ministry of Health of Great Britain concerning legal rights of property holders in underground waters. **Protection of Underground Water.** PERCY GRIFFITH, Ibid., 27: 196–8, 1925. Discussion of above report.—*Jack J. Hinman, Jr.* (*Courtesy Chem. Abst.*)

NEW BOOKS

Regulation of Rivers Without Embankments. As Applied in the Training Works at the Headwaters of the Rangoon River, Burma. (Locally known as the Myitmaka Training Works.) F. A. LEETE and G. C. CHEYNE. London: Crosby Lockwood and Son; New York: D. Van Nostrand Co. 122 pp. $12.—*R. E. Thompson.*

Public Health in Theory and Practice. WM. HENRY WELCH. New Haven, Conn.: Yale University Press; London: Humphrey Milford, Oxford University Press. Cloth; 5 x 8 inches; pp. 51. $1. Reviewed in Eng. News Rec. 95: 108, July 16, 1925.—*R. E. Thompson.*

The Public and Its Utilities. WM. G. RAYMOND. New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd. Cloth; 6 x 9 inches; pp. 346; appendix of operating expense tables, and amortization tables. $3.50. Reviewed in Eng. News Rec. 95: 109, July 16, 1925.—*R. E. Thompson.*

The Water Supply of Buildings and Rural Communities. WALTER S. L. CLEVERDON. New York: D. Van Nostrand Co. Cloth; 5 x 8 inches; pp. 186; appendix of 23 charts and tables. $2.50. Reviewed in Eng. News Rec., 95: 110, July 16, 1925.—*R. E. Thompson.*

The Principles of Public Health Engineering. EARLE B. PHELPS. New York; The Macmillan Co. Cloth; 6 x 9 inches; pp. 265; $3. Reviewed in Eng. News Rec. 95: 111, July 16, 1925.—*R. E. Thompson.*

The Transactions of the First World Power Conference, London, June 30 to July 12, 1924. Volumes I to IV. London: Percy Lund Humphries and Co., Ltd. Cloth; 7 x 10 inches; pages as follows: Volume I–1506, II–1599, III–1502, IV–1816; index in separate volume. Four volumes £10; index £2; both in London. Reviewed in Eng. News Rec. **95**: 110, July 16, 1925.—*R. E. Thompson*

Construction Plant, Methods and Costs: The Miami Conservancy District. Chas. H. Paul. Technical Reports, Part X. Dayton, Ohio: The Miami Conservancy District. Paper; 6 x 9 inches; pp. 411. $2. Reviewed in Eng. News Rec., **95**: 315, August 20, 1925.—*R. E. Thompson.*

Effective Regulation of Public Utilities. John Bauer. New York: The Macmillan Co. Cloth; 5 x 8 inches; pp. 381. $2.50. Reviewed in Eng. News Rec. **95**: 316, August 20, 1925. *R. E. Thompson.*

Practical Water Engineering. W. T. Taylor. Crosby Lockwood and Son. 270 pp. 36s., by post 36s. 9d. Reviewed in Munic. Eng., **76**: 9, July 2, 1925.—*R. E. Thompson.*

River Gauging: A Report on Methods and Appliances Suitable for Use in Great Britain. M. A. Hogan. H. M. Stationery Office. 70 pp. 2s. 6d., by post 2s. 9d. Reviewed in Munic. Eng. **76**: 59, July 16, 1925. *R. E. Thompson.*

A Bibliography of Bibliographies on Chemistry and Chemical Technology, 1900–1924, by Clarence J. West and D. D. Berolzeimer, is announced by the National Research Council, Washington, D. C., as their Bulletin No. 50 (308 p., $2.50). This work is composed of the following sections: General Bibliographies, Abstract Journals and Year-Books, General Indexes of Serials, Bibliographies of Special Subjects and Personal Bibliographies. As the title indicates, the work is a compilation of bibliographies published as separates, or at the end of books or magazine articles, or as footnotes to the same, on the numerous aspects of pure and applied chemistry. Each entry gives name of author or compiler, title, and place of publication. The majority of the entries state the number of references, thus giving an indication of the completeness of the particular bibliography. The entries are classified under the proper subject headings, alphabetically arranged. The duplication of individual entries has been largely avoided by the liberal use of cross-references. An approximate analysis shows that there are about 2400 subject headings, 7500 author entries and a total of 10,000 individual bibliographies. Although no claim is made for the completeness of the compilation, it is believed that the work will furnish a convenient starting point for any bibliographic search.